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OF
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Proceedings of the Fall Meeting

HELD AT

BRIDGEPORT, CONN., OCTOBER 11, 1902

AND ITS

Nineteenth Annual Meeting

AT

HARTFORD, FEBRUARY 10, 1903

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Connecticut Society of Civil Engineers

ORGANIZED AT BRIDGEPORT, JANUARY 15, 1884

◆

Officers for 1903

FREDERICK L. FORD, HARTFORD,	*President*
JOHN K. PUNDERFORD, NEW HAVEN,	*First Vice President*
THEODORE B. FORD, BRIDGEPORT,	*Second Vice President*
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HENRY J. KELLOGG, NEW HAVEN.
EDWIN D. GRAVES, HARTFORD.

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WITH DATES OF SERVICE

B. Hull	1884, 1885
Charles M. Jarvis	1886
Charles E. Chandler	1887
Charles H. Bunce	1888, 1889
F. Floyd Weld	1890
E. P. Augur	1891, 1892, 1893, 1894
Wm. G. Smith	1895, 1896
Robert A. Cairns	1897, 1898
Edwin D. Graves	1899, 1900
Henry J. Kellogg	1901
Clarence B. Vorce	1902

PROCEEDINGS

OF THE

Connecticut Society of Civil Engineers

AT THE

Fall Meeting Held at Bridgeport, Conn.,

October 11, 1902.

The fall meeting was held at Bridgeport on Saturday, October 11, 1902. The meeting was called to order at 10.30 A. M. by President Vorce. On motion it was voted reading of minutes be omitted. The President appointed Messrs. Henderson, Tracy and C. M. Crawford tellers, to count the ballot on the amendment to the Constitution. The following applications for membership were favorably reported by the Board of Direction:

Walter A. Brown, Springfield, Mass.; Leon F. Peck, Greenwich, Conn.; Elmer W. Stearns, Berlin, Conn.; James W. Phelps, Hartford, Conn.; F. Irwin Davis, Hartford, Conn.; Edward H. Everitt, New Haven, Conn.; Edgar H. Stiles, New Haven, Conn.; Fred H. Parsons, Bridgeport, Conn.; Paul Stirling, Bridgeport, Conn.

The Society proceeded to ballot on the names presented. Messrs. Bush and H. G. Clark were appointed to act as tellers by the President.

By ballot Messrs. Everitt, Brown and Parsons were elected active members of the Society. On motion it was voted that the Secretary cast one ballot for Messrs. Peck, Davis, Phelps, Stiles, Stearns and Stirling. They were then declared elected active members of the Society. And on motion it was voted, that the President appoint a committee to bring in the new members.

The tellers reported the ballot on the amendment as follows: Total number of votes cast 61, number for 58, number against 3. The amendments were then declared carried. They are as follows:

BALLOT FOR AMENDMENT TO CONSTITUTION.

ART. IV. SEC. 2. Clause 3 as at present.

At each annual meeting (except in 1901, when it may be done at any meeting) the Society shall choose a Nominating Committee of five, who shall submit to the Secretary, not less than sixty (60) days before the next annual meeting, the names of three candidates for each office. Letter ballots shall then be sent by the Secretary to each member, at least thirty (30) days before the day of the annual meeting.

Proposed Amendment:

The clause (at each annual meeting . . for each office) be stricken out and that the word "blank" be inserted before letter in the next clause, making it read. "Blank letter ballots containing a list of the officers to be voted for shall be sent by the Secretary to each member, at least thirty (30) days before the annual meeting."

ART. IV. SEC. 4. Clause 3 as at present.

If no candidate receives a majority of the votes for any office, then the meeting shall proceed to vote by ballot for the candidates receiving the highest number of letter votes, and a candidate receiving a majority of the votes of the meeting shall be declared elected.

Proposed Amendment:

To insert the word "two" before candidates, so that it will read. "If no candidate receives a majority of the votes for any office, then the meeting shall proceed to vote by ballot for the two candidates receiving the highest number of letter votes.

At 11.30 the members were taken over the works by the engineers in charge of the improvements, Mr. R. F. Stoddard, Mr. A. Terry and Mr. George Palmer. The members were also shown every courtesy by Mr. James Malloy of the J. Sheehan Co., M. J. Toole of the Dwight & Daley Co., and Edgar Stiles of Lathrop, Shea & Henwood.

The Bridgeport improvements now in course of construction for the new high level line of the N. Y., N. H. & H. R. R. consist of the elimination of some twenty-five grade crossings, bettering the alignment and grades, and putting in four tracks with 100 lbs. rail, also the building of a new station.

The railroad approaches Bridgeport from the west by a tangent running nearly due east; at Main street the line swings to the north in a very sharp curve, along the water front, then in front of the station swings to the east across the Pequonnock River, until it again reaches the old line in East Bridgeport.

In West Bridgeport the improvements consist of raising the tracks some fifteen feet, with retaining walls and steel bridges over twelve streets.

The middle section, along the water front and over the Pequonnock River for about 3,200 feet, is on a steel viaduct, consisting of steel plate girders carried on masonry piers, every fourth pier coming to bottom of girders, the intermediate low piers supporting steel columns spaced six feet on centers and about nine feet high.

At the Pequonnock River for about 600 feet all the piers are built up to the high level; on the east side the retaining walls and steel bridges over streets are the same as in West Bridgeport.

Along the water front the piers were built in two sections; as the main line here leaves but little room for working, only a short piece at the west end of each pier could be built. These portions of the piers were built in coffer dams, six-inch groove and tongue sheeting having to be used.

Spruce piles spaced two feet on centers were driven for foundation, then a concrete base with the easterly end a facing of granite is used. The upper part of this easterly face is left toothed.

A temporary trestle over the west ends of the piers was built to take care of the main line tracks, then the easterly ends of the piers were built, in an open caisson. These portions of the piers are built of granite with the western ends of piers toothed; when the caisson's sides are removed the two sections of the piers are filled in by fitting in and keying cut granite stones. About fourteen piers are built in this manner.

Open caissons were used for this work and for the river piers, built in the following manner: First, a grillage of three layers of 12″ x 12″ hard pine, the first course laid transversely, the second diagonally and the top longitudinally, for the roller lift pier four courses including a second diagonal layer, all drift bolted at each intersection with ⅞″ square drift bolts 18″ long.

The grillages were rafted and assembled in the water and the framed sides of the caisson attached by rods hung from the plates and hooking into eyebolts in the grillage to permit easy detachment. Sufficient interior cross bracing is also provided. The sheathing is of 3″ and 4″ planks calked with oakum.

A large amount of Portland cement concrete was used in the foundations of piers. The concrete was mixed in the proportion of one part Portland cement, three of sharp sand and six of clean coarse gravel; a cubical concrete mixer was used, twenty-four men and a small engine turning out about 125 cubic yards of concrete per day.

Small cars on a narrow gauge track carry the concrete in boxes holding about one cubic yard, the boxes have two leaved hinged bottoms; after the derrick has dumped its contents the swinging bottom is automatically closed by inclined side pieces on the cars, as the box is lowered on the car for the return trip.

The improvements were begun in the summer of 1899 and it will take at least another year to complete them.

When completed they will cost about $4,000,000.

Continuing the inspection the members visited with Mr. T. B. Ford the work of brick paving on Seaview avenue, and the completed Yellow Mill Pond drawbridge. A drizzling rain coming on at this time rather marred the remainder of the trip. But Mr. Leustcher and Mr. Stirling of the American Tube and Stamping Company showed the members about the extensive plant which they are constructing and did everything in their power to make their visit pleasant.

The American Tube and Stamping Company's new plant on Stratford avenue, visited by the Society, is to be a very modern open hearth steel plant. At present there will be three 35-ton basic open hearth furnaces with a thirty-four inch blooming mill.

The main building is 608 feet long and 110 feet wide, erected on three rows of concrete piers, one in the center and one on each side, spaced twenty feet apart.

The excavation for the foundation was begun in June and all brick work, foundations, etc., ready for the superstructure of iron were completed by the latter part of September.

The main building is entirely of iron, both roof and sides.

The columns are forty-two feet long, from top of piers to bottom of roof truss, and the maximum load on center columns 256,000 pounds.

All pier footings were built to stand a load of 3,000 pounds per square foot, and the pier proper 5,000 pounds per square foot.

All piers were of concrete, except those adjacent to the furnaces, which were of common red brick laid in Portland cement.

In the concrete was used four or five different brands of Portland cement with like good results, except in the length of time of setting. Two-inch clean trap rock was used and a very sharp clean sand that was found in the excavations.

The pier footings were put in 1–3–6 mixture and the pier proper 1–3–5. By a number of test blocks these two mixtures gave the best results. The foundations contained about 6,000 cubic yards. Four concrete gangs, consisting of a foreman and eleven or twelve men, were kept busy most of the time; each gang putting in an average of forty yards per day, all mixing being done by hand. A number of small piers with bolts, washers and templates set in each, and the constant shifting of the concrete board kept the daily average of yardage of each gang small.

For each style of pier four or five adjustable form boxes were made. The sides of the boxes were grooved so that the ends could set in and then the two sides tightened up by a couple of slotted 2″ x 6″ pieces with wedges driven up hard in the slotted end. This made a very easy box to set up and take down. All were constructed out of 1¼″, tongued and grooved, planed on one side, stuff. The boxes were set up one day, filled with concrete and the next morning taken down, not having more than a twenty-four hour set. This gave a chance to slush up the surface in a very satisfactory manner.

The bolts were all set with a six-inch piece of tin pipe around the top, giving a chance to adjust the bolt slightly to fit the shoe of the columns. These were afterward filled with grout when the columns were set and the building lined.

In the main building are four Shaw electric travelling cranes, running the entire length of 608 feet—the runway being twenty-five feet above the ground level. On the east half are two ten-ton and one fifty-ton cranes and on the west half one ten-ton crane; all of these have a span of about fifty-five feet. Besides these there is a yard crane of sixty foot span on a runway of 450 feet.

On the charging side of the furnaces is an iron platform ten feet above the ground level, running 220 feet. Upon this runs a Wellman-Seaver charging machine, besides a narrow gauge track carrying charging cars and boxes, each car when loaded carrying about ten tons of pig iron or two to six tons of scrap, according to shape and size, etc.

Next to the furnaces are two soaking pits (vertical underground heating furnaces), and then the mill and tables. The mill is run by a double reversing 48" x 60" engine, with direct connection to the mill by a so-called overhung crank. The runout table is on a grade of $^9/_{16}$ inches to the foot, raising the shear end enough to permit the billets to drop directly upon the billet cars, eliminating the necessity of a conveyor.

The foundation of the mill, engine and tables contained about 2,500 yards of concrete. The engine and mill foundation went down about eighteen feet. To prevent all likelihood of settlement a wall five feet deeper was run all around the outside of this deep foundation.

Besides the main building is a gas producer house 190' x 30' with fifteen foot high concrete walls and iron superstructure and roof; a boiler house 125 x 50, containing ten 230-horse power horizontal tubular return flue Bigelow boilers, with room for two additional boilers. The boilers will be fired with Buckwheat coal by Wilkinson mechanical stokers. The boiler stack is of brick, 135' high, 9' 6" inside diameter. A machine shop and dynamo house, 90 x 50. The machine shop contains large drill presses, lathes, shapers, etc., necessary for all of the heavy repair work of the shop. It is run by a 25-horse power motor.

The dynamo room contains three Ridgeway outfits, consisting of Thompson-Ryan dynamos and McEwen engines. They are 160 kilowatts each. Two are 220 volts for cranes, lights, etc., and one is 500 volts for the electric railroad.

The electric railroad is a trolley road about a mile long, connecting the shop yard with the N. Y., N. H. & H. R. R. freight yard. So freight cars are hauled directly from the railroad and placed wherever necessary in the shop yard. Upon this road is a standard railroad trestle 600 feet long and a large number of switches and sidings in the yard. The alignment of the yard tracks is limited to 100 feet radius curves and No. 4 frogs, which is found to be about the limit to operate the railroad's new 100,000 lbs. cars. The electric motor is from the General Electric Co., weighing 26 tons. It takes very easily three 80,000 lbs. cars around a 100 foot radius curve and a 2 per cent. grade.

In addition to the standard gauge tracks there are about two miles of three foot gauge track covering the shop yard and running down to the company's dock. This track is for running the shop, charging the furnaces, handling material, etc. All curves and switches are limited by 30 feet radius. It is operated by a Porter narrow gauge steam locomotive, and specially constructed charging, billet and combination cars.

The plant when completed will be the best equipped and one of the most modern ones of its kind in the country. It is expected it will be in operation in the early summer. Our member, Mr. Paul Stirling, has charge of the construction.

A vote of thanks was extended to the Bridgeport Traction Co. for cars furnished.

At 2.30 the members to the number of fifty sat down to an excellent dinner at Lehman's. Among those present were Messrs. Ferry, New Haven; H. R. Buck, Hartford; R. S. Kirby, Port Chester; Turner, New Haven; Bishop, Middletown; A. B. Hill, New Haven; Stiles, Bridgeport; Graves, Hartford; Stirling, Bridgeport; Geo. Palmer, New Haven; Leustcher, Bridgeport; Miller, New London; Powell, New London; R. N. Clark, Hartford; Smith, Hartford; T. S. Starr, Hartford; Hill, *Eng. News;* G. H. Sage, Berlin; J. T. Henderson, Hartford; F. I. Davis, Hartford; Edw. Bush, Hartford; C. Merrell, New Haven; J. H. Edwards, Hartford; Skinner, *Eng. Record;* C. W. Crawford, Hartford; Punderford, New Haven; Kelly, New Haven; B. D. Pierce, Bridgeport; Bunce, Hartford; Stearns, Hartford; F. O. Osborne, New Haven; Gladding, New Haven; Kellogg, New Haven; F. L. Ford, Hartford; E. M. Ryder, New Haven; W. B. Palmer, Bridgeport; H. Snell, Hartford; E. H. Owen, Greenwich; T. B. Ford, Bridgeport; R. P. Lewis, Waterbury; C. B. Vorce, Hartford; R. S. Stoddard, Bridgeport; C. N. Wood, Norwalk; W. H. Fulton, New Haven; A. Terry, Bridgeport; H. Storrs, New London; H. G. Clark, Hartford; J. F. Jackson, New Haven.

PROCEEDINGS

OF THE

NINETEENTH ANNUAL MEETING

OF THE

Connecticut Society of Civil Engineers

Hartford, Conn., February 10, 1903.

Convention called to order in the Council Chamber, City Hall, Hartford, at 10.20 A. M., President C. B. Vorce in the chair.

THE PRESIDENT: The first business before the meeting will be the appointment of tellers to canvass the ballot for officers for the ensuing year. I will appoint Mr. Henderson and Mr. Wilcox. As the polls do not close until 11 o'clock, any member who has not voted will please do so before that time.

The next thing before the meeting is the presentation of the minutes of the last meeting.

THE SECRETARY: Mr. President, the minutes of the annual meeting have been printed in the annual report. At the fall meeting in Bridgeport, held on October 11, 1902, there was no business transacted with the exception of the adoption of an amendment to the constitution and the election of the following new members:

Walter A. Brown, Springfield, Mass.; Leon F. Peck, Greenwich, Conn.; Elmer W. Stearns, Berlin, Conn.; James W. Phelps, Hartford, Conn.; F. Irwin Davis, Hartford, Conn.; Edward H. Everitt, New Haven, Conn.; Edgar H. Stiles, New Haven, Conn.; Fred H. Parsons, Bridgeport, Conn.; Paul Stirling, Bridgeport, Conn.

On motion by Mr. Bunce, the minutes were accepted as read and ordered printed in the Proceedings.

THE PRESIDENT: The next business before the Society is the report of the Board of Direction, which the Secretary will read.

THE SECRETARY: I have the following report from the Board of Direction:

A meeting of the Board of Direction was called at Hartford, June 28, 1902, but owing to lack of a quorum no business was transacted. Those present were President Vorce, First Vice President Ford and Mr. Bunce. A second meeting of the Board of Direction was held at Hartford, July 7, 1902, when the following business was transacted, viz: That the name of B. H. Hull of Bridgeport be recommended to the Society for a place on the honorary list of membership, and that the name of J. W. Knowlton be stricken from the roll of members. Also, that the Secretary write again to several members who were in arrears for dues. In reference to a communication received from the German Society of Engineers in regard to the Connecticut Society of Civil Engineers coöperating in the furnishing of data for a technolexicon to be published by them, it was voted that, owing to press of other affairs the Society felt obliged to respectfully decline at this time to participate.

It was voted that the Secretary send a postal to each member requesting suggestions as to a meeting in the late summer or early fall.

Those present were President Vorce, First Vice President Ford, Mr. Cairns, Mr. Bunce and Mr. Kellogg.

A third meeting of the Board of Direction was held at Hartford September 16, 1902. Present: President Vorce, First Vice President Ford, and Messrs. Punderford, Bunce and Kellogg. It was voted that Mr. Edgar Clark of Putnam be recommended for honorary membership.

The following names were stricken from the roll of members: H. L. Davis, H. G. Loomis, W. H. Olmstead, W. S. Robb, R. J. Sabin, George B. Rogers, Hugo Schaeffer, and H. B. Tabor.

The resignation of George B. Lund was received and accepted. The resignation of W. C. Marshall was laid upon the table.

A communication received from J. R. Ockerson, Chief, Department of Liberal Arts, World's Fair, St. Louis, was referred to the Society for consideration at its nineteenth annual meeting.

A meeting was held at Bridgeport, October 11, 1902, when the following applications for membership were approved:

Walter A. Brown, Springfield, Mass.; Leon F. Peck, Greenwich, Conn.; Elmer W. Stearns, Berlin, Conn.; James W. Phelps, Hartford, Conn.; F. Irwin Davis, Hartford, Conn.; Edward H. Everitt, New Haven, Conn.; Edgar H. Stiles, New Haven, Conn.; Fred H. Parsons, Bridgeport, Conn.; Paul [illegible], Bridgeport, Conn.

A fourth meeting of the Board of Direction was held at Hartford January 10, 1903, when it was voted that the resignation of [illegible] Marshall be taken from the table, and it was voted to accept same. Voted, that the annual meeting be held in Hartford, the arrangements for same to be left in the hands of a committee to be appointed by the President. It was also voted that the President secure the best person possible to talk on "concrete."

A fifth meeting of the Board of Direction was held at Hartford February 10, 1903, when the accounts of the Treasurer were audited and found correct, and the following applications for membership approved: B. H. Hull and Edgar Clark for honorary members and Frederick S. Chapman, New London, Conn.; William R. C. Corson, Hartford, Conn.; Aubrey D. Fuller, New Haven, Conn.; Percy T. W. Hale, Portland, Conn.; F. B. Hastings (Associate), Bridgeport, Conn.; Adrian C. Heitman, Jr., West Haven, Conn.; Frank B. Jaynes, Bridgeport, Conn.; Walter A. Jones, New Haven, Conn.; Edwin M. Lee, New Haven, Conn.; Robert Q. MacMahon, New London, Conn.; Major Chas. F. Powell, New London, Conn.; George E. Smith, Derby, Conn.; Joseph P. Wadhams, Torrington, Conn.; Frederick S. Wardell, Stamford, Conn., for active and associate members.

Present President Vorce, First Vice President Ford, Second Vice President Punderford, Mr. Bunce and Mr. Kellogg.

Respectfully submitted by the Board of Direction,

CLARENCE B. VORCE,
FRED'K L. FORD,
JOHN K. PUNDERFORD,
CHAS. M. JARVIS,
ROBT. A. CAIRNS,
CHAS. H. BUNCE,
HENRY J. KELLOGG.

On motion by Mr. Kellogg the report was accepted as read and ordered printed in the Proceedings.

The President: The next matter before the meeting is the report of the Secretary.

The following report was submitted by Secretary Jackson:

"To the Officers and Members of the Connecticut Society of Civil Engineers:

Your Secretary respectfully submits the following report for the past year.

During the latter part of May one thousand copies of the Eighteenth Annual Report were printed and distributed to the members, to those societies with whom we exchange, and to different libraries and institutions of learning. The estimate of one thousand copies proved much too small, and the Secretary has had many requests for extra copies from engineers located in all parts of the world,—from Nova Scotia to New Zealand,—and from members whose copies through change of address or other cause had gone astray. These, much to his regret, he was not able to grant. One hundred extra copies could easily have been disposed of.

On September 29 letter ballots for the proposed new amendment were sent to all members, together with notice of the fall meeting, which was held at Bridgeport. Through the effort of the committee in charge, to whom many thanks are due for a successful meeting, the Society inspected the different interesting pieces of work in progress, after which they partook of an excellent dinner. The tour of inspection was greatly curtailed by the rain which came on during the latter part of the afternoon. About fifty members were present.

Early in January letter ballots for officers were sent out, and in the latter part of the month the notices of the annual meeting. Through the efforts of President Vorce, Mr. H. J. Kellogg and others, the receipts from advertisements have been increased about twenty per cent. for the Eighteenth Annual Report. And the Society now has assured between four and five hundred dollars' worth of advertisements for the Nineteenth Annual Report.

During the year fourteen new members have been elected; two have resigned, ten have been dropped, and one honorary member, Mr. Edward S. Waters, died December 26, 1902.

SUMMARY FOR THE YEAR.

	Feb. 10, 1902.	Feb. 9, 1903.	ADDITIONS.		LOSSES.			
			Transfers.	Elected.	Death.	Resign'd	Transfers.	Dropped
Honorary....	9	8	2	....	1	....	....	....
Active......	198	200	....	14	....	2	....	10
Associate...	2	2	....	....	....	....	....	....
Totals....	209	210	2	14	1	2	....	10

On motion by Mr. Buck the report was accepted as read and ordered printed in the Proceedings.

THE PRESIDENT: The next on the order of business is the report of the Treasurer.

Treasurer J. Frederick Jackson submitted the following report.

J. Frederick Jackson, Treasurer, in account with the Connecticut Society of Civil Engineers for the year ending February 9, 1903:

RECEIPTS.

Received from	Former Secretary	$176.47
"	Advertisements, 1902	579.00
"	" 1903	10.00
"	Back Dues	113.00
"	Dues, 1902	435.00
"	" 1903	171.00
"	Sale of Reports	11.50
"	Dinner Tickets	127.50
"	Ransom & Smith—Cost of Cut for Adv.	4.05
"	Joseph Dixon Co., Cost of altering Cut	.35
"	Envelopes returned	.55
		$1,628.42

DISBURSEMENTS.

Annual Reports	$615.76
Cartage	2.25
Dinners	135.00
Expressage	51.39
Freight	6.97
Postage	35.84
Printing, Stationery and Supplies	175.81
Rent of P. O. Box	2.00
Rent of Rooms for Meetings	4.00
Stenographer's Services	63.54
Traveling Expenses of Secretary	19.60
Salary, Secretary and Treasurer	50.00
Cash on hand February 9, 1903	466.26
	$1,628.42

THE PRESIDENT: Gentlemen, you have heard the report of the Treasurer. I am sure it is a gratification to us to know that the cash on hand is nearly $300 more than it was last year. I do not want to cast any slurs on the last administration, because it is more of an evidence of the growth of our Society than of any good work of ours except a little extra push in regard to getting advertisements.

On motion the report was accepted as read and ordered printed in the Proceedings.

THE PRESIDENT: The next order of business is the report of the Special Committees.

The first on the list is the report of the Committee on Sewerage. Mr. Cadwell, Chairman.

MR. CADWELL: Mr. President, I will hand in my report a little later.

THE PRESIDENT: If the Society decides not to have these reports read, I presume that will be entirely satisfactory.

On motion by Mr. Kellogg it was voted that the reports of committees be read by title only.

REPORT OF THE COMMITTEE ON SEWERAGE.

NEW BRITAIN, CONN., 1903.

To the President and Members of the Connecticut Society of Civil Engineers:

Your Committee on Sewerage submits the following report, showing by the tabulated tables herewith attached the larger part of the work done in the State during the past year in this branch of engineering; the tables also show what is contemplated as far as can be learned for the ensuing year. The report of your Committee on Sewerage last year came near exhausting this field of inquiry, so that we need not make excuses for making a short report this year. Nearly all of the cities of the State have done more or less sewer work and some of the towns have built small sewerage systems. There has been, as far as your Committee has been able to learn, only one disposal plant completed during the past year, that at Ridgefield, Conn., which is a Downward Intermittent Filtration System.

There is also a filtration system building at New Britain that will be completed during the present year and put into use next fall. The filtration systems of Meriden and Danbury are doing their work in a satisfactory manner. The systems at South Manchester and Bristol are in operation, together with several small systems at private institutions.

When properly cared for the results from the filtration systems in this State are very satisfactory. There are still many complaints and suits from the use of waterways as carriers for sewage which will probably continue until municipalities large and small care for their sewage by some approved system.

The past year has witnessed some advance in the treatment of sewage by the use of the septic tank and contact filters, which show that this system or some modification thereof will solve this problem where suitable material is not available for Downward Intermittent Filtration. There has been some change made in several of the cities by substituting concrete in the construction of catch-basins and manholes, instead of brick, which demonstrates the fact that considerable saving can be made by its use.

The City of New Britain is now building all of its manholes and catch-basins of Portland cement concrete at a saving of a little more than one-third of the cost of brick, and is getting stronger and better work. They have also adopted the use of tarred jute well tamped into place either with a caulking iron or point of trowel, and reinforced with Portland cement collars, in making up the joints of the small vitrified pipe sewers; even then there is a small amount of ground water finds its way into the sewers.

We think that this question of ground water should be investigated in order that the amount leaking into a given length of pipe sewer in a given watershed could be ascertained or determined in relation to the rainfall of the season for reference or comparison.

Also that an inquiry should be started to gather information in regard to specially constructed outfall sewers along the coast line or on the larger rivers of the State.

Respectfully submitted,
Wm. H. Cadwell,
Henry R. Buck,
Commitee on Sewerage.

CITY.	Lineal Feet.	Material.	Size.	Cut.			Cost.		
				Deepest.	Shallowest.	Average.	Contract.	Day Labor.	
Bridgeport.....		Cement Pipe Brick	10″x15″ to 44″	19	5	12	970′ [illegible]5.47= $5,305.90		Grav
Danbury,......		Pipe	3″ 10″ 12″ 15″	20	4.5	12			Hard
Hartford.......	27053.5	Salt-glazed Vitrified Tile	10″ to 24″	22.1	3 (fill)	10	$52,510.94	$ 2,083.00	All
Meriden	7010.98		6″ to 10″	18	4	10.5		*14,428.00 7,381.83	All
	2350	Cast iron pipe syphon	18″			6.5			
Middletown....		Vitrified Pipe	12″ (main) 8″ (inlets) 6″ (no spurs)	12	8	9′		1,054.00	Filled Clay
New Britain ...	4700	Salt glazed Vitrified Pipe	8″	13.5	3	7			Grave Hard
	3619		10″						
	6696		12″						
	5074		15″						
	361		18″						
	378		20″					20,577.53	
		31 Filter Beds, Sandstone Gravel, one acre each, comprising:							
		65,000 yds loam					15c. per cu. yd.		
		65,000 yds. gravel					17½c. per cu. yd.		
		25,000′ 5″ underdrains					10c. per lin. ft.		
		2,700′ 6″ "					10c. " "		
		2,600′ 8″ "					10c. " "		
		3,300′ 9″ "					12c. " "		
		4,500 sq. yds. turfing					40c. " sq. yd.		
		1,000 cu. yds. screened gravel					32c. " cu. yd.		
		5,100′ 24″ pipe					40c. " lin. ft.		
		1,100′ 18″ pipe					22c. " "		
		450′ 12″ pipe					15c. " "		
		95 cu. yds. Masonry					[illegible].25 " cu. yd.		
		19 Manholes					$45		
		2 Screen Chambers					$75		
		60 sq. yds. paving					27c. per cu. yd.		
		3,000′ effluent ditches					23c. " lin. ft.		
		1,500 sq. feet heavy Riprap.					07c. " sq. ft.		
		Supplies for Beds: Pipe Stone Cement Valves Iron Pipe.					$ 8,000		
		Straightening 4000′ of Brook channel					40,000 Total cost	10,000	
New Haven....	2468.4	Vitrified Pipe	12″	18	9	12	*$1.14 per lin. ft.		All
	1739.6		15″				1.31		
	902.1		18″				1.24		
	1233.0	Brick	24″				2.61		
New London ..	525	Underdrain	3″					3,804.79 (For labor only)	747′ in
	929	"	4″	12		7			
	156	"	6″						
	5029	Salt-glazed Vitrified Pipe	8″						
	611		10″						
Norwich*......	6193		4″-6″ (Ho. con.)						
	8038.7		8″						
	759.5		10″						
	4013		12″						
	57		15″						
	10023.5		Service Pipe					$18,000	
South Norwalk		Vitrified Pipe	10″ 12″	24′	3′	9.5′	$15,500		Rock
Stamford.......	5000	Vitrified Pipe	8″ 12″ 15″	10	2.5	7			Earth
Waterbury	4410 7040	Sanitary Surface Water chiefly Vitrified Pipe	8″ to 27″	13	1 (fill)	7			
West Hartford.		Akron Tile	8″ 10″		8.5		$902.88		Earth Hardp

We add a table showing the year's work in the State as re-
rted.

Also complete specifications for Section One and Two of the ew Britain Sewerage System, recently let by contract.

SECTION 1.

GENERAL INFORMATION.

Sealed bids will be received for the complete comstruction of thirty-
e (31) filter beds in the Town of Berlin, together with all under-
ins, manholes, main feeders, screens, chambers, ditches, embankments, ves, all as detailed under the different sections in the plans and speci-
tions.

The City to furnish all materials on the premises as hereinafter speci-
l.

Bids will be received at the office of the Sewer Commissioners, 213 in street, New Britain, Conn., until 4 o'clock P. M., August 18, 1902.

Bids must be made upon blanks annexed hereto and should give the es for each item both in writing and figures and be signed by the der with his business address and place of residence.

Each bid must be accompanied by a certified check for One Thousand lars ($1,000) made payable to the Treasurer of the City of New tain. Such check to be returned to the bidder unless forfeited under conditions herein stipulated.

Surety Company's bond will be required (satisfactory to Sewer mmissioners) for the sum of Ten Thousand Dollars ($10,000) for faithful performance of the contract within one (1) week from date mailing of a notice from the Board to the bidder as per address in bid, stating that the contract is ready for signature, and in case of ure or neglect so to do it will be considered that he has abandoned contract and the certified check accompanying the proposal shall be eited to the City of New Britain, Conn.

ll bids will be compared on the basis of the Engineer's estimate of work to be done as per list.

he plans and specifications for the work are the property of the ineer and are in every case to be returned to him.

e following will be used as a basis to compare all bids for work ded under SECTION ONE (1).

ENGINEER'S ESTIMATE.

65,000 cubic yards of loam and materials to be removed from the ce of the 31 proposed filter beds and used for embankments or ed.

65,000 cubic yards of gravel to be handled or leveled in forming

3d. 25,000 lineal feet of 5 inch underdrains.
4th. 2,700 lineal feet of 6 inch underdrains and branches.
5th. 2,600 lineal feet of 8 inch underdrains and branches.
6th. 3,300 lineal feet of 9 inch underdrains and branches.
7th. 4,500 square yards of turfing.
8th. 1,000 cubic yards of screened gravel for driveways and walks.
9th. 5,100 lineal feet of 24 inch pipe trunk or main feeders to be laid.
10th. 1,100 lineal feet of 18 inch pipe trunk or main feeders to be laid.
11th. 450 lineal feet of 12 inch pipe laterals leading to the beds to be laid.
12th. 95 cubic yards of stone masonry in bulkheads or piers.
13th. 19 manholes complete with all apparatus set.
14th. Two screen chambers complete as per detail.
15th. 60 square yards of paving at outfalls to underdrains.
16th. 3,000 lineal feet of ditches discharge of effluent.
17th. 1,500 square feet of heavy riprap at railroad bridge.

These quantities are only approximate and are given only as a basis of comparison of bids. The Sewer Board reserves the right to increase or decrease the amount under each and any item as may be deemed advisable or necessary by the Engineer and to reject any and all bids should the Sewer Board deem it to be for the best interest of the City of New Britain to do so. Also notice is hereby given that any contract for the work herein specified or any other which may be added will be subject to approval and ratification by the Common Council of the City of New Britain.

Office of BOARD OF SEWER COMMISSIONERS.
W. H. CADWELL, *Engineer.*
S. H. STEARNS, *Chairman.*
EDGAR H. BEACH.
JAMES HEALY.

PROPOSAL

TO THE BOARD OF SEWER COMMISSIONERS OF THE CITY OF NEW BRITAIN FOR SECTION ONE (1) OF THE NEW BRITAIN SEWERAGE SYSTEM.

The undersigned (bidder) herein declares that no other person, firm or corporation is interested in this proposal and that this bid is not made with collusion with any other person, firm or corporation; that he has examined the location of the proposed works, and the plans herein referred to and proposes and agrees with the City of New Britain that if this bid is accepted that he will enter into a contract with said City through its Board of Sewer Commissioners of the form herewith attached, to provide all necessary machinery, tools, apparatus and other means of construction and to do all the work and furnish all the materials specified, in manner and time therein specified and according to the requirements of the Engineer as therein set forth and that he will take in full payment thereof the sums named in this bid, to wit:

1st. For excavating and removing all of the surface loam to be removed from the surfaces of the proposed thirty-one (31) filter beds, as specified under this head, the sum of ....
..................................($...............) per cubic yard.

2d. For carting, leveling and grading all gravel to properly construct the thirty-one (31) filter beds, the sum of ....
..................................($...............) per cubic yard.

3d. For laying 5 inch pipe underdrains, the sum of ....
..................................($...............) per linear foot.

4th. For laying 6 inch pipe underdrains, the sum of ....
..................................($...............) per linear foot.

5th. For laying 8 inch pipe underdrains, the sum of ....
..................................($...............) per linear foot.

6th. For laying 9 inch pipe underdrains, the sum of ....
..................................($...............) per linear foot.

7th. For laying the turf, the sum of ....
..................................($..............) per square yard.

8th. For preparing and placing the screened gravel, the sum of ....
..................................($...............) per cubic yard.

9th. For laying the 24 inch pipe sewer, the sum of ....
..................................($...............) per linear foot.

10th. For laying the 18 inch pipe sewer, the sum of ....
..................................($...............) per linear foot.

11th. For laying the 12 inch pipe laterals, the sum of ....
..................................($...............) per linear foot.

12th. For laying the stone masonry in bulkheads and piers, the sum of
..................................($...............) per cubic yard.

13th. For building the manholes, complete, the sum of ....
..................................($........................) each.

14th. For building the screen chambers, complete, the sum of ....
..................................($........................) each.

15th. For laying the cobble paving, the sum of ....
..................................($..............) per square yard.

16th. For building the outfall ditches for effluent, the sum of ....
..................................($...............) per linear foot.

17th. For building the riprap, the sum of ....
..................................($..............) per square foot.

For extra work and materials, if any, the City will allow and pay the Contractor the actual cost to him of said work plus 10 per cent. of such cost. Said work to be done only upon written order of the Engineer and then done only in the way described by said Engineer.

Provided this proposal shall be accepted by the Board of Sewer Commissioners and said acceptance ratified by the Common Council of the City of New Britain, Conn., and the undersigned shall fail to contract as aforesaid and to give the bond as before described in the sum of Ten Thousand Dollars ($10,000) (the Surety Company being satisfactory to said Board of Sewer Commissioners), within one week from the date of mailing of a notice from said Board of Sewer Commissioners to the Contractor according to the address herein given that the contract is ready for signature, then the said Contractor shall be considered to have abandoned the contract, and the certified check for One Thousand Dollars ($1,000) accompanying this bid or proposal shall become the property of the said City of New Britain, otherwise the said check shall be returned to the undersigned.

Dated ....

The full name and residence of all the persons or parties interested in the foregoing bid as principals are as follows:

....

....

....

The bidder will state below what work similar in character, to that described and included in this proposal, he has done and give references that will enable the Board to judge of his experience and business standing.

....

....

The bidder will give below the Surety Company which he expects to furnish the Ten Thousand Dollar ($10,000) bond if the bid or proposal is accepted.

....

CONTRACT.

CITY OF NEW BRITAIN, CONN., ACTING THROUGH ITS BOARD OF SEWER COMMISSIONERS.

Contract for constructing SECTION ONE (1) of the proposed new Separate Sewerage System of the City of New Britain, Conn., said Section being situated in the Town of Berlin, Conn.

This agreement made and concluded this........day of.............. in the year one thousand nine hundred and two (1902), by and between the City of New Britain, acting by its Board of Sewer Commissioners, party of the first part, and ....

....

hereinafter designated as the Contractor, as party of the second part, witnesseth:

GENERAL CONDITIONS.

ARTICLE I. The Contractor shall do all work and furnish all the materials except as herein otherwise specified, necessary or proper for the construction and completion of the work hereinafter specified.

ART. II. The word "Board" shall mean the Board of Sewer Commissioners of New Britain, Conn. The words "Chief Engineer" shall mean the person holding the position or acting in the capacity of Chief Engineer of the Board. The word "Engineer" when not further qualified shall mean the Chief Engineer, acting either directly or through his properly authorized agents, such agents acting within scope of the particular duties intrusted to them. Whenever any power is possessed by, or act or thing is to be done by the Board under this contract, the exercise of such power or the doing of such act or thing by the Board or any member thereof shall be a sufficient compliance with the terms of this contract.

ART. III. All the work under this contract shall be done to the satisfaction of the Chief Engineer, who shall in all cases determine the amount, quality and acceptability of the several kinds of work and materials which are to be paid for under this contract and shall decide all questions which may arise as to the faithful performance of the terms of this contract by the Contractor and said Engineer's decision shall be final and conclusive, and in case any question shall arise shall be a condition precedent to the rights of the Contractor to receive any money hereunder.

ART. IV. The Board will require the Contractor to start this work within ten (10) days after the contract is signed and to finish the same within the time hereinafter specified.

SPECIFICATIONS.

ART. I. The work to be done under SECTION 1 is situated all in the Town of Berlin, Conn., near the Southeast Corner of the Town of New Britain and consists of building thirty-one (31) filter beds of about one acre each, together with all the appurtenances or parts to make the same complete, all as detailed on the various maps and profiles in the office of the Board and Chief Engineer (W. H. Cadwell).

The Contractor is to furnish everything whether labor or materials for the completion of said thirty-one (31) beds, screen chambers, drains, ditches, etc., except as herein specified under the different heads in this contract and in compliance with the requirements of the Engineer thereunder.

ART. II. The work, during its progress and on its completion must conform with the lines and levels given by the Engineer subject to such modifications or additions as shall be deemed necessary during the execution of the work, and in no case will any work in excess of the requirements of the plans be paid for except the same be ordered in writing by the Chief Engineer.

ART. III. The Contractor shall remove all the loam, grass, brush, stumps and all other objectionable substances or material from the entire surface of all the filter beds and use the same in making embankments, raising roads on or near the premises, keeping the best loam to line or face the sides of all embankments, dikes or ditches. Any and all surplus loam or objectionable substances shall be wasted, where and as directed by the Engineer, always keeping the best for the top. Contractor will excavate to the depth required and clear the entire area of all the beds of all loam, muck, stumps, rock or other objectionable substances and dig out and remove any pockets of poor material and prepare the surface of each filter bed for either leveling or filling up with the borrowed gravel as the case may be.

The materials to be removed will all be paid for and measured in the bank by careful cross-section.

Contractor will furnish all labor and proper tools to form all of the embankments of this waste material and can in many cases use the gravel that now exists where the embankments are to be built and maintained. Contractor will be required to use modern methods and appliances in handling this material and in no case will he be allowed to form driveways over any portions of the area comprising filter beds.

Art. IV. The Contractor will, after all loam and other objectionable materials have been removed from the area or surface of the filter beds, proceed to excavate, grade and level same by such approved methods as shall have been approved by the Engineer to the required level, the center of all beds being kept two (2) inches higher than the edges of the same. The Contractor after bringing the beds to the approximate grade shall plow the same nine (9) inches deep with approved plows and shall remove all cobbles or boulders encountered or found greater than will pass through a two and one-half (2½) inch ring in the operations and replace same with suitable gravel after the underdrains have been laid. Contractor will then do the finishing grading and bring the beds to a true surface required and called for by the stakes and marks set for same. Care shall be taken by the Contractor in moving the gravel or other material to avoid forming paths or other objectionable depressions or compressions of the gravel and if there should be any formed the Contractor will be required to remedy same without additional pay, to the satisfaction of the Engineer before the next payment shall become due.

The gravel to be moved or carted will all be paid for from, and measured in the bank by careful cross-section. Contractor will do all possible carting and other transportation on the embankment.

Art. V. Contractor will excavate for, and lay the 5 inch, 6 inch, 8 inch and 9 inch underdrains together with all branches, said drains to be laid as shown on the sections of the filter areas or beds and will average about 5 feet deep. Contractor will draw the pipes from the pile on the premises and lay the same where and as directed, all to be laid to lines with pole and plumb. Grade plank to be set by Contractor every twenty-five (25) feet and carefully maintained. Said pipe underdrains are all to be laid true to line and grade. The joints to be in all cases left open but covered with a 6 inch strip of heavy burlap. Each pipe to be laid by hand and securely rapped into place to avoid any settlement. Contractor shall carefully carry out all the directions of the Engineer in regard to the said underdrains and shall do no carting over said underdrains unless the same are covered with at least 4 feet of gravel over the tops of said drains. The City will furnish all pipe for the underdrains on the premises. Contractor will be held responsible for same after contract is signed and the pipe delivered.

ART. VI. Contractor shall cart, excavate for and lay the 24 inch and 18 inch sewer pipe, and such iron pipe as is shown on the details at the Railroad Crossing forming the main or trunk sewers together with all manholes, gates, etc., to complete same as a whole. Said 24 inch and 18 inch pipe to be laid to a line and grade with pole and plumb bob. Contractor to set and use proper grade plank one to every twenty-five (25) linear feet to set the grade upon, all of said pipe to be laid with hemp or oakum joints calked with calking iron and covered with Portland cement mortar, made one-half Atlas cement and one-half sharp coarse sand, over the entire joints. Contractor shall keep said main sewer pipes true to a line and clear away any obstructions or projections. The City furnishes all the pipe, oakum or hemp and Portland cement on the premises. Contractor shall cut and fit all of said 24 inch or 18 inch trunk sewer pipes to carry out the plans, and set all gates, valves, and manholes to make same complete.

ART. VII. Contractor will cart, excavate for and lay the 12 inch sewer pipe from the manholes to the individual filter beds as per plans, laid in every particular the same as specified for the 24 inch and 18 inch pipe trunk sewers in the next preceding item or article.

ART. VIII. Contractor will cart and place 8 inches of the best loam, obtainable from the fields owned by the City near the filter beds, or found in stripping the said filter beds, on the edges of the driveways and on all the slopes of all of the embankments around all of the filter beds and lay a border one foot wide of the best turf that can be found on the City property within one thousand (1,000) feet of the filter-beds on each side of all of said drives and at such other points as directed by the Engineer.

Said turf to be laid true to grade, tamped, rolled, watered thoroughly to make a workmanlike job. The turf to be cut uniform in width and in pieces of not less than two foot lengths, said turf to be selected and satisfactory in every way, and laid with slight depression at intervals of one hundred (100) feet as directed by Engineer, to allow the surface water to escape to the beds.

ART. IX. Contractor will screen and distribute on the entire surface of all the drives and walks of the entire Filtration System coarse gravel 2 inches in depth. The gravel to consist of gravel that will pass through a mesh three-quarters of an inch in diameter and not smaller than one-quarter of an inch in diameter. The subgrade of the drives and walks being properly formed to conform in shape and outline with the directions of the Engineer before applying said gravel, then spread the gravel and rake and true up same. The gravel to be applied after the turf borders have been laid. Contractor shall keep the embankments and drives in perfect condition till accepted by the City and shall then be subject to the general condition governing the final acceptance of the whole job.

Art. X. Contractor will excavate for the manholes to the proper size to allow for their proper construction.

Contractor will furnish the materials to make the forms of, and build the distributing manholes required in the entire section or job. The manholes to be built of Atlas Portland cement mortar and crushed stone as per details. The City furnishing all of the stone, cement and castings on the ground or at the store-house near the works. The Contractor to furnish suitable coarse sharp sand.

The concrete used in the manholes is to be made of one part Atlas Portland cement and two and one-half parts suitable and satisfactory sand and five parts broken stone that will pass through a 1 inch ring. The stone to be wet before adding to or mixing with the cement mortar, then the whole shall be thoroughly mixed by hand in a mortar bed or on a platform with water and shall be placed in position forming the manholes in layers of not more than 8 inches in height and rammed and tamped to form a solid homogeneous mass. The Contractor will make tight form to hold same in place till set, and after two days shall remove the form and plaster the back and inside surface of said manholes with Portland cement perfectly smooth, the inside being given a wash of neat Portland. The bottoms shall also be finished in the same manner. Contractor shall take special care in forming the corners or angles in said manholes to get such a form or shape that there will be no places to hold a deposit of sewage or other matter, and will set all bolts to hold copings or gates and gate frames required. After the manholes are complete with all connections made and gates set, Contractor will refill around said manholes and tamp same and do any and all work necessary to complete same to the entire satisfaction of the Engineer.

Art. XI. Contractor will build the stone bulkheads for the discharge of the underdrains and the intakes to the filter beds all as per details, also the stone piers to support the iron or steel main sewer where the same passes across the Railroad Right of Way and under the bridge over Willow Brook. The City will furnish all stone on the premises, also the cement for the job under this article. The Contractor will furnish all tools, labor, sand and all other materials necessary and excavate and build such bulkheads and pier as per details complete. All to be laid with field stone and done in first-class manner. The work will be paid for by the cubic yard measured after being laid, the price per yard to include the said stone work complete as constructed and no extras will be allowed in connection with the same only as may be ordered under the general conditions.

Art. XII. Contractor will pave the outlets of the underdrains with sound hard field cobble stone of not less than 6 inches in diameter or more than 10 inches laid the longest diameter vertical, laid in 4 inches of sand, tamped, rammed and finished in a workmanlike manner, and if made on filling, said filling shall be rammed and puddled at least two weeks previous to doing the paving. The finished surface of the paving shall conform with the lines given or as directed by the Engineer. After paving is laid Contractor will fill the entire surface with coarse sand or gravel to wedge stone into place.

ART. XIII. Contractor will excavate for, grade and slope the ditches for the effluent as shown on the detail drawings and as laid out by the Engineer on the ground. The side slopes to be 1¾ to 1 and they are to have a continuous down grade from the highest point to the brook or river: no pockets or depressions will be allowed for the effluent to stand or pond. All surplus materials taken from said ditches shall be so distributed to make a finished and uniform surface satisfactory to the Engineer, the loam being kept on the surface.

ART. XIV. Contractor will haul and lay the field stone riprap near the brook at the Railroad bridge as shown on the detail drawings. Said riprap to be composed of field stone of not less than 12 inches in diameter, to be found on the property of the City of New Britain within fifteen hundred (1,500) feet of the place showing the riprap and are to be laid in the usual manner, the longest diameter towards the embankment and at right angles thereto. All to be laid to lines fixed by batter boards and set from stakes or lines given by the Engineer and to be constructed in a workmanlike manner with all the holes chinked up tight and the bottom or foundation excavated for and carried to solid ground and below possibility of frost affecting same.

ART. XV. If solid rock ledge is encountered or found in the excavation in building any part of the work that requires blasting to handle same in the opinion of the Engineer, or any solid boulder, exceeding in volume one cubic yard, the Contractor is to remove same and if suitable in the opinion of the Engineer for rubble work, Contractor shall break same up and use them where stone is called for. All such boulders or ledge rock if not suitable for use in the opinion of the Engineer, shall be wasted and placed where directed and covered with loam.

Any and all ledge rock or boulders above described, if any, will be paid for by the City, whether used on the job or wasted at the rate of 75-100 dollars per cubic yard from actual measurements, by the Engineer.

ART. XVI. Contractor shall excavate for and construct two screen chambers as per detail drawings.

Excavate 18 inches deeper and larger all around than the outer size or dimensions of said screen chambers and build a stone rubble wall of suitable local stone to be found within fifteen hundred (1,500) feet of location of said screen chambers or furnished by the City, said walls to be laid solid in Portland cement mortar same as called for in Article II. Said stone to be laid with allowance for brick veneering to be done with white enameled brick furnished by the City, laid in stretchers and bonded to the stone work with galvanized iron bonds.

Contractor shall cope all the walls of said chambers with granite coping furnished by the City. Contractor shall set all gates, screens and other iron work or anchors, entering into the construction of said chambers as per detail drawings for same. The City furnishing all materials except the sand entering said screen chambers.

Contractor shall before the said walls are laid lay a bed of Portland cement and stone concrete about one foot thick of the same mixture and made in the same manner as called for in Article X, over the entire floor surface of the chambers including the walls thereof. After the rubble walls are laid around said chambers Contractor will lay and bed the 4 inch planed bluestone flags over the bottom of said chambers so that they shall form a perfect grade as given by the Engineer. After laying said flags Contractor will then lay the enameled brick as above specified and set the coping and complete same. The enameled brick are to be laid with about 3-16 full mortar joints and jointed with straight edge in a workmanlike manner.

ART. XVII. Contractor shall examine all materials and not allow any defective materials to enter into the work in any of its parts and if any is found he must remove and replace same at once at his own expense as to the labor or the City can do so at his expense.

ART. XVIII. Contractor shall do all fitting or cutting of the pipe or other materials at his own expense without additional compensation other than that specified under each of the several items herein specified.

ART. XIX. Contractor shall use 2 per cent. salt in all mortar made and used during frosty weather and shall protect all masonry work from the elements at all times till final acceptance of the job by the City.

ART. XX. Contractor shall maintain existing fences or any others which the City may have built and shall repair and replace any that may be taken down or damaged during the work or acceptance of the work under this contract.

ART. XXI. Contractor shall at completion of this work or contract remove all temporary structures built by him and all rubbish and surplus materials of all kinds from the site of the works and shall leave the grounds in a neat and clean condition.

ART. XXII. Contractor shall instruct any and all foremen or superintendents working for him that they shall at all times receive and obey orders from the Engineer. Failure to obey such orders will be cause for dismissal by the Engineer.

ART. XXIII. All lines and grades furnished by the City and given by the Engineer shall be carefully maintained and preserved by the Contractor, who shall furnish the Engineer any and all assistance that may be required to establish the same at all times.

ART. XXIV. Contractor shall provide proper conveniences for the men and if shanties are built shall keep same in a perfectly sanitary condition satisfactory at all times to the Engineer and the Health Committee of the City or its representatives.

ART. XXV. The plans are hereby made a part of this contract and shall consist of not only the small scale drawings but all necessary large size details as may be deemed necessary and shall be considered as explanatory of the work in hand. Should any error appear or discrepancy occur in either, the explanation of the Engineer shall be final and binding on the Contractor or City. Any correction of errors or omissions in either plans or specifications may be made by the Engineer which are necessary for the proper execution of this contract as contract is construed by him.

Art. XXVI. The Engineer, Board of Sewer Commissioners and such other persons as they shall authorize shall have access to the whole premises and shall be at all times the persons in charge or control of the premises and are to be at liberty to carry on such other work as they may deem necessary at all times.

Art. XXVII. Any work found at any time to have been done wrong or not in accordance with the plans and specifications, or as directed, or that is defective in any way before final acceptance, shall be immediately made good by Contractor or at his expense by the City without further notice. The Contractor shall be holden for the whole job till the final acceptance of the same and be responsible for the materials furnished by the City, the City having the right to ask for a receipt from the Contractor for all materials delivered and furnished by them to him. The giving of any certificate of payment shall be in no way or manner considered as an acceptance of any part of the work under this contract.

Art. XXVIII. The Contractor shall discharge any man or men in his employ on this work whom the Engineer specifies as incompetent in writing and shall not re-employ the same only with the consent of the Engineer.

Art. XXIX. Contractor shall not claim, and hereby agrees not to claim, any damages because of delays which may arise in getting supplies or materials, or from legal complications which may arise, or from any cause whatsoever. But the Contractor shall have the time extended for finishing the work as long as delayed by such unforseen circumstances.

Art. XXX. The Contractor shall indemnify the City or Town of New Britain for any expense which may be incurred by said City or Town by reason of the bringing into said City or Town of laborers, not now residents of said City or Town, by said Contractor, and shall save the City from any expense therefrom, either from any of the men becoming a public charge in any way or from any other cause, and said bond herein specified shall be considered as given in part to guarantee said City or Town against any such expense or charge.

Art. XXXI. The Contractor shall give preference in employing laborers or others on this work, first, to citizens of the City or Town of New Britain, Conn., second, to residents in the State of Connecticut, and third, to citizens of the United States, and shall confer with the Engineer in regard to the employment of all capable laborers or mechanics possible in the construction of this work that are residents of the City or Town of New Britain. The same to apply to the hiring of teams.

Persons employed in the performance of manual labor under the contract shall not be required to work more than nine hours in each day, and nine hours shall constitute a day's work.

Art. XXXII. Contractor shall give his constant personal attention to the faithful prosecution of the work and at all times shall keep the same under his personal control, and shall not sublet the whole or any part of the work without the previous written consent of the Board, nor shall he assign any moneys payable under the agreement and shall pay all workmen employed on the works promptly every week as per laws of State of Connecticut.

ART. XXXIII. The Engineer may make alterations in the grades, lines, plans, form, or materials of the work either before or after the commencement of the construction, and, if such alterations diminish the amount of work to be done, the Contractor shall have no claim for damages as anticipated profits on the work effected by the changes, and if the amount be increased such increase shall be paid for according to the quantity of work actually done and at the price bid for said work and under this contract or proposal.

ART. XXXIV. Contractor shall commence work on this contract within ten days after the full execution of the contract by the Board, and shall continue said work uninterruptedly till completed with a satisfactory force of men and machines, and shall have the North Filtration area "A," done, together with the screen chambers and all of the several parts pertaining to the same and included under this contract December 1, 1902, and the South Filtration area "B," together with all that pertains to the same, July 1, 1903.

ART. XXXV. Contractor shall and hereby agrees to allow the Board to deduct the sum of One Hundred Dollars ($100.00) for each and every day that said work is not completed as specified above from any moneys due on this contract as liquidated damages (said forfeiture to apply equally to each portion of the work as mentioned above), subject to any extension of time either allowed by said Board or caused by them by delays, as hereinbefore set forth.

ART. XXXVI. The Contractor shall take and assume all responsibility of the work and take all precautions for preventing injuries to persons and property in or about the work, shall bear all losses arising from injury to persons or property by reason of the work under this contract or any other cause, and shall save the City or Town of New Britain harmless from any liability therefrom.

ART. XXXVII. If the work under this contract shall be abandoned, or if this contract shall be sublet without consent, or the contract or any claim thereunder shall be assigned by the Contractor otherwise than as herein specified, or if at any time the Engineer shall be of opinion, and shall so certify in writing to the Board, that the conditions herein specified as to the rate of progress are not fulfilled, or that the work, or any part thereof, is unnecessarily or unreasonably delayed, or that the Contractor is violating any of the provisions of this contract, the Board may notify the Contractor to discontinue all work or any part thereof and thereupon the Contractor shall discontinue such work or such part thereof as the Board may designate, and the Board may thereupon, by contract or otherwise, as it may determine, complete the work, or such part thereof, and charge the expense thereof to the Contractor, and may take possession of and use therein such materials, animals, machinery, implements, and tools of every description as may be found upon the line of said work. The expenses so charged shall be deducted and paid to the Board out of any moneys then due or to become due the Contractor under this contract, or any part thereof; and in case such expense is less than the sum which would have been payable under the contract if the same had been completed by the Contractor, the Contractor shall be entitled to receive the difference; and in case such expense shall exceed the latter sum, the Contractor shall pay the amount of such excess to the City.

Art. XXXVIII. The Contractor shall pay the City all expenses, losses and damages, as determined by the Engineer, incurred in consequence of any defect, omission or mistake of Contractor or his employees, or the making good thereof.

Art. XXXIX. The Contractor shall do any work not herein otherwise provided for, if required, and when and as directed in writing by the Engineer or his agents, specially authorized thereto in writing, and there shall be no claim for extra work and materials or for damages sustained, except under this article, and he shall, before the fifteenth day of the month succeeding that in which any extra work is done, or materials furnished, or damages sustained, by him, file with the Engineer and with the Board a claim for such damages or extra work or materials, with the order, or copy thereof, on which the work or materials were furnished, and shall, when requested by the Engineer so to do, file an itemized statement of and vouchers for the quantities and prices of such work, materials or damages.

Art. XL. The City may keep any moneys which would otherwise be payable at any time hereunder and apply the same, or so much as may be necessary therefor, to the payment of any expenses, losses or damages incurred by the City under any of the provisions of this contract, and may retain until all claims are settled so much of such moneys as the Board shall be of opinion will be required to settle all claims against the City or the Board and their officers and agents, under Article XXXVII or otherwise, and all claims for labor or materials for work, notice of which, signed and sworn to by the claimants, shall have been filed in the office of the Board, or may make such settlements and apply thereto any moneys retained under this contract. The Board also may, upon written consent of the Contractor, use any moneys retained, due or to become due under this contract, for the purpose of paying for the labor of materials for the work, for which claims have not been filed in the office of the Board.

Art. XLI. The City shall pay as full compensation for everything furnished and done by the Contractor under this contract, and also for all loss or damage arising out of the nature of the work aforesaid, or from the action of the elements or from any unforeseen obstruction or difficulty encountered in the prosecution of the work, and for all risks of every description connected with the work, and for all expenses incurred by or in consequence of the suspension or discontinuance of the work herein specified, and for well and faithfully completing the work, and the whole thereof, as herein provided as follows:

1st. For excavating and removing all of the surface loam to be removed from the surfaces of the proposed thirty-one (31) filter beds, as specified under this head, the sum of............................
..................................($..............) per cubic yard.

2d. For carting, leveling and grading all gravel to properly construct the thirty-one (31) filter beds, the sum of ....
..................................($..............) per cubic yard.

3d. For laying 5 inch pipe underdrains, the sum of................
..................................($..............) per linear foot.

4th. For laying 6 inch pipe underdrains, the sum of ....
..................................($..............) per linear foot.

5th. For laying 8 inch pipe underdrains, the sum of ....
..................................($..............) per linear foot.

6th. For laying 9 inch pipe underdrains, the sum of ....
..................................($..............) per linear foot.

7th. For laying the turf, the sum of ....
..................................($..............) per square yard.

8th. For preparing and placing the screened gravel, the sum of......
..................................($..............) per cubic yard.

9th. For laying the 24 inch pipe sewer, the sum of ....
..................................($..............) per linear foot.

10th. For laying the 18 inch pipe sewer, the sum of ....
..................................($..............) per linear foot.

11th. For laying the 12 inch pipe laterals, the sum of ....
..................................($..............) per linear foot.

12th. For laying the stone masonry in bulkheads and piers, the sum of
..................................($..............) per cubic yard.

13th. For building the manholes, complete, the sum of ....
..................................($......................) each.

14th. For building the screen chambers, complete, the sum of ....
..................................($......................) each.

15th. For laying the cobble paving, the sum of ....
..................................($..............) per square yard.

16th. For building the outfall ditches for effluent, the sum of ....
..................................($..............) per linear foot.

17th. For building the riprap, the sum of ....
..................................($..............) per square foot.

For extra work and materials, if any, as specified in Article XXXIX, the reasonable cost of work and materials, as determined by the Engineer, plus 10 per cent. of such cost.

ART. XLII. The Engineer shall, once each month, make an estimate in writing of the total amount of work done to the time of such estimate and the value thereof. The City shall retain 25 per cent. of such estimated value as part security for the fulfillment of this contract by the Contractor, and shall monthly pay to the Contractor, while carrying on the work, the balance not retained as aforesaid, after deducting therefrom all previous payments and all sums to be kept or retained under the provisions of this contract. No such estimate or payment shall be required to be made when, in the judgment of the Engineer, the total value of the work done since the last estimate amounts to less than three hundred dollars. Payment may at any time be withheld if the work is not proceeding in accordance with the contract. At the option of the Board, estimates may be made more frequently, and a smaller amount may be retained as aforesaid.

The Engineer shall, as soon as practical after the completion of the contract, make a final estimate of the amount of work done under this contract and the value thereof, and the City shall, within sixty days after such final estimate is so made and is approved by the Board, pay the entire sum so found to be due hereunder, after deducting therefrom all previous payments and all amounts to be kept and all amounts to be retained under the provisions of this contract. All prior partial estimates and payments shall be subject to correction in the final estimate and payment.

ART. XLIII. Neither the City or the Board, nor any member or agent thereof, shall be liable for, or be held to pay, any money to the Contractor, except as provided in Articles XLI and XLII; and the acceptance of the last payment aforesaid shall operate as, and shall be a release to the City, the Board, and any member and agent thereof, from all claim and liability to the Contractor for anything done and furnished for, or relating to, the work, for any act or neglect of the City or of any person, relating to or affecting said work, except the claim against the City for the remainder, if any there be, of the amounts kept or retained as provided in Article XL.

IN WITNESS WHEREOF, The parties hereunto set their hands, in triplicate the ....day of .... in the year 1902.

....
....
....

Board of Sewer Commissioners.

....
....
....

Contractors.

WITNESSES:
....
....

NOTICE.—The surety bond to be given and attached to the copy of the signed contract which the City is to keep, is to specifically state that the same is given to protect the City fully in accordance with all the conditions of a contract entered into by the City and the party named in said surety bond as Contractor, and is to be satisfactory to said Board of Sewer Commissioners in every way before it will be accepted.

SECTION 2.

GENERAL INFORMATION.

Sealed bids will be received for the complete construction of a tunnel in the town of New Britain, together with all manholes and approaches to said tunnel, all as detailed in the plans and specifications for the same.

The city to furnish all materials on the premises as hereinafter specified.

Bids will be received at the office of the Sewer Commissioners, 213 Main street, New Britain, Conn., until 4 P. M., January 6, 1903.

Bids must be made upon blanks annexed hereto and should give the prices for each item both in figures and in writing and be signed by the bidder with his business address and place of residence.

Each bid must be accompanied by a certified check for One Thousand Dollars ($1,000) made payable to Treasurer of the City of New Britain. Such check to be returned to the bidder unless forfeited under the conditions herein stipulated.

A Surety Company's bond will be required (satisfactory to the Sewer Commissioners) for the sum of Five Thousand Dollars ($5,000), for the faithful performance of the contract, within one (1) week from date of the mailing of a notice from the Board to the bidder as per address in bid, stating that the contract is ready for signature, and in case of failure or neglect so to do it will be considered that he has abandoned the contract and the certified check acompanying the proposal shall be forfeited to the City of New Britain, Conn.

All bids will be compared on the basis of the Engineer's estimate of the work to be done as per list.

The plans and specifications are the property of the Engineer and are in every case to be returned to him.

The following will be used as a basis to compare all bids for work included under SECTION Two (2).

ENGINEER'S ESTIMATE.

1st. Building 1,048 linear feet tunnel, measured from center of manholes.

2d. Building four (4) manholes as per detail drawings.

3d. Excavating 1,556 cubic yards of earth in trench work not including tunnel.

4th. Excavating 922 cubic yards of rock excavations in trenches for 24 inch pipe and manholes.

5th. Laying 680 linear feet of 24 inch pipe sewer as per profile.

6th. Laying brick masonry in tunnel.

7th. Laying 24 inch sewer in tunnel.

These quantities are only approximate and are given only as a basis of comparison of bids. The Sewer Board reserves the right to increase or decrease the amount under each and any item as may be deemed advisable or necessary by the Engineer and to reject any and all bids should the Sewer Board deem it to be for the best interest of the City to do so. Also notice is hereby given that any contract for this work herein specified or any other which may be added will be subject to the approval and ratification by the Common Council of the City of New Britain.

Office of BOARD OF SEWER COMMISSIONERS.
W. H. Cadwell, S. H. Stearns, *Chairman.*
Engineer. Edgar H. Beach.
James Healy.

PROPOSAL

To the Board of Sewer Commissioners of the City of New Britain, for Section Two (2) of the New Britain Sewerage System.

The undersigned (bidder) herein declares that no other person, firm or corporation is interested in this proposal and that this bid is not made with collusion with any other person, firm or corporation; that he has examined the location of the proposed work, and the plans herein referred to and proposes and agrees with the City of New Britain that if this bid is accepted that he will enter into a contract with said City through its Board of Sewer Commissoners of a form herewith attached, to provide all necessary machinery, tools, apparatus and other means of construction and to do all the work and to furnish all the materials specified, in manner and time therein specified and according to the requirements of the Engineer as therein set forth and that he will take in full payment thereof the sums named in this bid, to wit:

1st. For excavating and building, complete, the tunnel of about 1,048 feet, for the sum of ....($.............) per linear foot complete.

2d. For building four (4) manholes, the sum of.................... ....($.................) per manhole.

3d. For excavating and back filling 1,556 cubic yards of earth in the trench work, the sum of ....($..............) per cubic yard.

4th. For excavating and caring for the rock excavation in the approaches to the tunnel, estimated at 922 cubic yards, the sum of ....($..............) per cubic yard.

5th. For laying about 680 feet of 24 inch pipe sewer, for the sum of ....($..............) per linear foot.

6th. For laying brick work in tunnel, the sum of ....($.............) per cubic yard.

7th. For laying 24 inch sewer in tunnel, the sum of ....($..............) per linear foot.

For extra work and materials, if any, the City will allow and pay the Contractor the actual cost to him of said work plus 10 per cent. of such cost. Said work to be done only upon written order from the Engineer and then done only in the way described by said Engineer.

Provided that this proposal shall be accepted by the Board of Sewer Commissioners and said acceptance ratified by the Common Council of the City of New Britain, Conn., and the undersigned shall fail to contract as aforesaid and to give the bond as before described in the sum of Five Thousand Dollars ($5,000) (the Surety Company being satisfactory to the Board of Sewer Commissioners), within one week from the date of mailing of a notice from said Board of Sewer Commissioners to the Contractor, according to the address herein given, that the contract is ready for signature, then the Contractor shall be considered to have abandoned the contract, and the certified check for One Thousand Dollars ($1,000) accompanying the bid or proposal shall become the property of the City of New Britain, otherwise the said check shall be returned to the undersigned.

Dated ....

The full name and residence of all persons or parties interested in the foregoing bid as principals are as follows:

....

....

The bidder will state below what work, similar in character to that described and included in this proposal, he has done and give reference that will enable the Board to judge of his experience and business standing.

....

....

The bidder will give below the Surety Company which he expects to furnish the Five Thousand Dollar ($5,000) bond if the bid or proposal is accepted.

....

....

CONTRACT.

City of New Britain, Conn., through its Board of Sewer Commissioners.

Contract for constructing Section Two (2) of the proposed new Separate Sewerage system of the City of New Britain, Conn., being situated in the Town of New Britain, Conn.

This agreement made this............day of.................in the year one thousand nine hundred and three (1903) by and between the City of New Britain, acting through its Board of Sewer Commissioners, party of the first part, and ....

....

hereinafter designated as the contractor, as party of the second part, witnesseth:

General Conditions.

Article I. The Contractor shall do all work and furnish all materials except as herein otherwise specified, necessary or proper for the construction and completion of the work hereinafter specified.

Art. II. The word "Board" shall mean the Board of Sewer Commissioners of New Britain, Conn. The words "Chief Engineer" shall mean the person holding the position or acting in the capacity of Chief Engineer of the Board. The word "Engineer" when not further qualified shall mean the Chief Engineer, acting either directly or through his properly authorized agents, such agents acting within scope of the particular duties intrusted to them. Whenever any power is possessed by, or act or thing is to be done by the Board under this contract the exercise of such power or the doing of such act by the Board or any member thereof shall be sufficient compliance with the terms of this contract.

Art. III. All the work under this contract shall be done to the satisfaction of the Chief Engineer, who shall in all cases determine the amount, quality and acceptability of the several kinds of work and materials which are to be paid for under this contract and shall decide all questions which may arise as to the faithful performance of the terms of this contract by the Contractor, and said Engineer's decision shall be final and conclusive, and in case any question shall arise shall be a condition precedent to the rights of the Contractor to receive any money hereunder.

Art. IV. The Board may require the Contractor to start this work within thirty (30) days after the contract is signed and to finish the same within the time hereinafter specified.

Specifications.

Article I. The work to be done under Section Two (2) is situated all in the Town of New Britain, Conn., near the East line of New Britain and consists of building a tunnel of one thousand and forty-eight (1,048) feet together with all the appurtenances or parts to make the same complete, all as detailed on the various maps and profiles in the office of the Board and the Chief Engineer (W. H. Cadwell). Also build the approaches to said tunnel with the manholes completing this section.

The Contractor to furnish everything, whether labor or materials for the completion of said tunnel, etc., except as herein specified under the different heads in this contract and in compliance with the requirements of the Engineer thereunder.

Art. II. The work, during its progress and on its completion must conform with the lines and levels given by the Engineer, subject to such modifications or additions as shall be deemed necessary during the construction of the work, and in no case will any work in excess of the requirements of the plans be paid for except the same be ordered in writing by the Chief Engineer.

Art. III. The Contractor shall furnish all the tools, materials and labor necessary to build the tunnel complete as per plans, profiles and detail drawings of the Sewer Department, furnished by the Engineer.

The excavation shall be made to the established grade and allowance being made to carry the bottom of the excavation 3 inches below the grade shown on profile as the water line, and the excavations shall not be less than 5 feet 0 inches wide or 2 feet 6 inches each side of the center line and the height in the clear or top of the tunnel shall not be less than six (6) feet above the grade shown on the profile. All loose stone or other material to be removed.

All surplus material taken from the east end of the tunnel and the approach shall be used in grading the highway within four hundred feet of the east end of said tunnel and said materials shall be deposited as directed by the Engineer on said adjoining highway or the adjoining land as per grades and directions by the Engineer.

All surplus material taken from the west end of the tunnel and the approach thereof shall be deposited in the cemetery lot west of the railroad tracks as directed by the Engineer in charge and fill up the low portion of said Fairview Cemetery west of the railroad tracks.

The bottom of the tunnel shall be excavated in the form of a half circle or segment of circle as shown on the details of said tunnel.

The Contractor shall concrete the bottom of said tunnel with Portland cement concrete, made by mixing one part of Atlas Portland cement, or equal furnished by the City, with two parts coarse Plainville sand mixed and used fresh, and form the bottom of said tunnel as per detail drawings. Said concrete bottom to be laid to a line and form and shall be true to the established grade of said tunnel throughout. The surface shall be hard finished with neat Atlas Portland cement, rubbed down with proper tools. Contractor shall care for and keep the water from running over and injuring said cement concrete until the same is hard.

All the above work is included in the price per foot named in the bid for said tunnel.

The Board of Sewer Commissioners reserve the right to order brick arches placed in any poor places in the roof or sides of said tunnel if in the opinion of the Engineer any is required, the same beng paid for as hereinafter provided.

The Board also reserves the right to have 24 inch pipe laid through said tunnel the same as in the approaches, in which case the concrete will be omitted. The payment for laying the 24 inch pipe (if ordered by the Engineer) will be in accordance with the bid for said work and in accordance with the specification hereinafter set forth.

Art. IV. The Contractor shall excavate for and build the four manholes as per plans and specifications, of concrete. The City furnishing the cement, castings, pipe and special ladders for same on the ground ready for use. The Contractor furnishing the balance of the materials, forms and all labor and tools to complete said manholes as per details. The Contractor shall excavate for said manholes, all earth and rock excavations being figured in the yardage of the approaches and paid for as hereinafter described. Excavate to the depth required to get the concrete shown on the drawings into proper place. Make the concrete of Atlas Portland cement, or equal, furnished by the City, two parts Plainville sand or equal furnished by the Contractor and four parts of 1 inch stone all measured and thoroughly mixed, tempered, tamped and used fresh, plastering, pointing and neatly finishing same both inside and outside to the acceptance of the Engineer.

ART. V. The Contractor shall excavate all the earth and other materials (not solid ledge rock or boulders more than one-half cubic yard each) for the construction of the four manholes and the two approaches as shown and required to properly construct same, and after the said manholes are built and the sewer laid in the approaches the Contractor shall fill around same, back filling the best material around the pipe and manholes and hand tamping same to the satisfaction of the Engineer. Any surplus materials shall be disposed of as under Art. III.

The Contractor shall puddle the earth back into the trench so as to avoid settlement.

Contractor will be paid for the excavation and back-filling by the cubic yard as per bid.

ART. VI. The Contractor shall excavate all rock found in the excavating for the manholes and approaches to a point 6 inches below the water line of the sewer pipe and 6 inches larger on the bottom half of said pipe measured from the inside of same. The solid rock or boulder (of more than ½ cubic yard) shall be paid for by the cubic yard measured as follows. All solid ledge rock requiring blasting to get it out (in the opinion of the Engineer) lying within six (6) inches of the bottom half of the sewer pipe, measured from the inside of same which make the rock to be paid for in the trench three feet wide at the center of the pipe, and the City paying for all rock, as before specified, which is actually taken out by the Contractor within the lines having an outward slope of three inches to each foot rise from said center line of sewer pipe on each side of said trench, and for no rock taken out beyond said lines, except what is actually necessary to build the manholes as specified, will be allowed or paid for. The price per cubic yard is to include the refilling or removal of any surplus to the dumping place referred to under Art. III. of the tunnel.

ART. VII. Contractor shall cart, excavate for and lay the 24 inch sewer pipe in the approaches which is furnished by the City, to complete same as a whole, said 24 inch pipe to be laid to a line and grade with pole and plumb bob. Contractor shall set and use proper grade planks, one every twenty-five (25) linear feet, to set the grade upon, all of said pipe to be laid with hemp or oakum joints calked with calking iron and covered with Portland cement mortar, made one-half Atlas cement and one-half sharp, coarse sand, over all joints.

Contractor shall keep said main sewer pipes true to a line and clear away any obstructions or projections. The City furnishes all the pipe, oakum or hemp and Portland cement on the premises. Contractor shall cut and fit all of said 24 inch trunk sewer pipes to carry out the plans, and set and fit same to manholes to make same complete.

Contractor shall refill and tamp with proper material around said 24 inch pipe with iron tamps to make same solid to the satisfaction of the Engineer in charge. The Contractor will be holden for all damage to material furnished by the City after delivery on or near the work.

ART. VIII. Contractor shall build brick arches or linings in the tunnel if ordered by the Engineer in charge, the City furnishing the brick and cement on the premises at convenient points, said arches or linings to be laid to lines and grades given by the Engineer; the brick being laid in well tempered cement mortar made of one part cement to two parts coarse Plainville sand, laid in a workmanlike manner by brick or sewer mason, and to be paid for by the cubic yard at the price specified in the proposal herewith attached.

The Contractor shall furnish all necessary forms for said work and do all of the same to the entire satisfaction of the Engineer.

ART. IX. The Contractor shall, if ordered by the Engineer, omit the concrete specified for the bottom of the tunnel and will lay one line of 24 inch sewer pipe furnished by the City through said tunnel, laid as specified for 24 inch sewer pipe in the approaches under Art. VII.

The price named in the proposal under the VIIth item shall include all the work of properly laying said line of 24 inch pipe per foot, allowing the proper reduction of omitting the concrete bottom.

The 24 inch pipe shall be securely blocked in place with stone, but no filling will be required except at the manholes.

ART. X. Contractor shall examine all materials and not allow any defective materials enter into the work in any of its parts, and if any is found he must remove and replace same at once at his own expense as to labor, or the City can do so at his expense.

ART. XI. Contractor shall do all fitting or cutting of the pipe or other materials at his own expense without any additional compensation other than that specified under each of the separate items herein specified.

ART. XII. Contractor shall use 2 per cent. salt in all mortar made and used during frosty weather and shall protect all masonry work from the elements at all times until final acceptance of the job by the City.

ART. XIII. Contractor shall maintain existing fences or any others which the City may have built and shall repair and replace any that may be taken down or damaged during the work or acceptance of the work under this contract. Contractor shall replace the surface of the ground at the west approach to its natural condition and the east approach as directed by the Engineer.

ART. XIV. Contractor shall, at completion of this work or contract, remove all temporary structures built by him and all rubbish and surplus materials of all kinds from the site of the works and shall leave the grounds in a neat and clean condition.

ART. XV. Contractor shall instruct any and all foremen or superintendents working for him, and they shall at all times receive and obey orders from the Engineer. Failing to obey such order will be cause for dismissal by the Engineer.

Art. XVI. All lines and grades furnished by the City and given by the Engineer shall be carefully maintained and preserved by the Contractor, who shall furnish the Engineer any and all assistance that may be required to establish same at all times.

Art. XVII. Contractor shall provide proper conveniences for the men and if shanties are built shall keep same in perfectly sanitary condition, satisfactory at all times to the Engineer and Health Committee of the City, or its representatives.

Art. XVIII. The plans are hereby made a part of this contract and shall consist of, not only small scale drawings, but all necessary large size details as may be deemed necessary, and shall be considered as explanatory of the work in hand. Should any error appear or any discrepancy occur in either, the explanation of the Engineer shall be final and binding on the Contractor or City. Any correction of errors or omissions in either plans or specifications may be made by the Engineer which are necessary for the proper execution of this contract as the contract is construed by him.

Art. XIX. The Engineer, Board of Sewer Commissioners, and such other persons as they shall authorize, shall have access to the whole premises, and shall be at all times the persons in charge or control of the premises, and are to be at liberty to carry on such other work as they may deem necessary at all times.

Art. XX. Any work found at any time to have been done wrong or not in accordance with the plans and specifications or as directed, or that is defective in any way before final acceptance, shall be immediately made good by Contractor or at his expense by the City without further notice. The Contractor shall be holden for the whole job until the final acceptance of the same and be responsible for the materials furnished by the City, the City having the right to ask for a receipt from the Contractor for all materials delivered and furnished by it to him. The giving of any certficate of payment shall be in no way or manner considered as an acceptance of any part of the work under this contract.

Art. XXI. Contractor shall discharge any man or men in his employ on the work whom the Engineer specifies, in writing, as incompetent, and shall not re-employ the same only with the consent of the Engineer.

Art. XXII. Contractor shall not claim, and hereby agrees not to claim, any damages because of delays which may arise in getting supplies or materials, or from legal complications which may arise, or from any cause whatsoever. But the Contractor shall have the time extended for finishing the work as long as delayed by unforeseen circumstances.

Art. XXIII. The Contractor shall indemnify the City or Town of New Britain for the expense which may be incurred by said City or Town by reason of the bringing into said City or Town of laborers, not now residents of the City or Town, by said Contractor, and shall save the City from any expense therefrom, either from any of the men becoming a public charge in any way, or from any other cause, and said bond herein specified shall be considered as given in part to guarantee said Town or City against any such expense or charge.

ART. XXIV. The Contractor shall give preference in employing laborers or others on this work, first, to the citizens of the City and Town of New Britain, Conn., second, to residents of the State of Connecticut, and third, to citizens of the United States, and shall confer with the Engineer in regard to the employment of all capable laborers or mechanics possible in the construction of this work, and are residents of the City and Town of New Britain. The same to apply to the hiring of teams.

Persons employed in the performance of manual labor under the contract shall not be required to work more than nine hours in each day, and nine hours shall constitute a day's work.

ART. XXV. Contractor shall give his constant personal attention to the faithful prosecution of the work and at all times shall keep the same under his personal control, and shall not sublet the whole or any portion of the work without the previous written consent of the Board, nor shall he assign any moneys payable under the agreement and shall pay all workmen employed on the works promptly every week as per laws of State of Connecticut.

ART. XXVI. The Engineer may make alterations in grades, lines, plans, form, or materials of the work, either before or after the commencement of the construction, and, if such alterations diminish the amount of work to be done the Contractor shall have no claim for damages as anticipated profits on the work effected by the changes, and if the amount be increased such increase shall be paid for according to the quantity of work actually done and at the price bid for said work under this contract or proposal.

ART. XXVII. Contractor shall commence work on this contract within thirty (30) days after the full execution of the contract by the Board, and shall continue said work uninterruptedly until completed, with a satisfactory force of men and machines, and shall have the whole complete and ready for use, together with all that pertains to the same, October 1, 1903.

ART. XXVIII. Contractor shall and hereby agrees to allow the Board to deduct the sum of Fifty Dollars ($50.00) for each and every day that said work is not completed as specified above, from any moneys due on this contract, as liquidating damages, subject to any extension of time either allowed by said Board or caused by them by delays, as herein set forth.

ART. XXIX. The Contractor shall take and assume all responsibility of the work and take all precautions for preventing injuries to persons and property in or about the work, shall bear all losses arising from injury to persons or property by reason of the work under this contract or any other cause, and shall save the City or Town harmless from any liability therefrom.

Art. XXX. If the work under this contract shall be abandoned, or if the contract shall be sublet without consent, or the contract or any claim thereunder shall be assigned by the Contractor otherwise than herein specified, or if at any time the Engineer shall be of opinion, and shall so certify in writing to the Board, that the conditions herein specified as to the rate of progress are not fulfilled, that the work, or any part thereof, is unnecessarily or unreasonably delayed, or that the Contractor is violating any of the provisions of this contract, the Board may notify the Contractor to discontinue all work or any part thereof as the Board may designate, and the Board may thereupon, by contract or otherwise, as it may determine, complete the work, or such part thereof, and charge the expense thereof to the Contractor, and may take possession of and use therein such materials, animals, machinery, implements, and tools of every description as may be found upon the line of said work. The expenses so charged shall be deducted and paid to the Board out of any moneys then due or to become due the Contractor under this contract or any part thereof; and in case such expense is less than the sum which would have been payable under this contract if the same had been completed by the Contractor, the Contractor shall be entitled to receive the difference; and in such case the expense shall exceed the latter sum the Contractor shall pay the amount of such expense to the City.

Art. XXXI. The Contractor shall pay the City all expenses, losses and damages, as determined by the Engineer, incurred in consequence of any defect, omission or mistakes of the Contractor or his employees or the making good thereof.

Art. XXXII. The Contractor shall do any work not herein otherwise provided for, if required, and when and as directed in writing by the Engineer or his agents, specially authorized thereto in writing, and there shall be no claim for extra work and materials furnished or damages sustained, except under this article, and he shall before the fifteenth day of the month succeeding that in which any extra work is done, or materials furnished, or damages sustained, by him, file with the Engineer and with the Board a claim for such damages and extra work or materials, with the order or copy thereof, on which work or materials were furnished, and shall, when requested by the Engineer so to do, file an itemized statement of and vouchers for the quantities and prices of such work, materials or damages.

Art. XXXIII. The City may keep any moneys which would otherwise be payable at any time hereunder and apply the same or so much as may be necessary therefor, to the payment of any expenses, losses or damages incurred by the City under any of the provisions of this contract, and may retain until all claims are settled so much of moneys as the Board shall be of opinion will be required to settle all claims against the City or Board and their officers and agents, under Article XXX or otherwise, and all claims for labor and materials for work, notice of which, signed and sworn to by the claimants, shall have been filed in the office of the Board, or may make such settlements and apply thereto any moneys retained under this contract. The Board also may, upon written consent of the Contractor, use any moneys retained, due or to become due under this contract, for the purpose of paying for labor or materials for the work, for which claims have not been filed in the office of the Board.

ART. XXXIV. The City shall pay as full compensation for everything furnished and done by the Contractor under this contract, and also for all loss or damage arising out of the nature of the work aforesaid, or from the action of the elements or from any unforeseen obstruction or difficulty encountered in the prosecution of the work, and for all risks of every description connected with the work, and for all expenses incurred by or in consequence of the suspension or discontinuance of work herein specified and for well and faithfully completing the work and the whole thereof, as herein provided as follows:

1st. For excavating and building, complete, the tunnel of about 1,048 feet, for the sum of ....
..........................($.............) per linear foot complete.

2d. For building four (4) manholes, the sum of,....................
....................................($.................) per manhole.

3d. For excavating and back filling 1,556 cubic yards of earth in the trench work, the sum of ....
....................................($...............) per cubic yard.

4th. For excavating and caring for the rock excavation in the approaches to the tunnel, estimated at 922 cubic yards, the sum of.........
....................................($...............) per cubic yard.

5th. For laying about 680 feet of 24 inch pipe sewer, for the sum of
....................................($..............) per linear foot.

6th. For laying brick work in tunnel, the sum of ....
....................................($...............) per cubic yard.

7th. For laying 24 inch sewer in tunnel, the sum of..................
....................................($..............) per linear foot.

For extra work and materials, if any, as specified in Article XXXII, the reasonable cost of work and materials as determined by the Engineer, plus 10 per cent. of such cost.

ART. XXXV. The Engineer shall, once each month, make an estimate in writing of the total amount of work done to the time of such estimate and the value thereof. The City shall retain 25 per cent. of such estimated value as part security for the fulfillment of this contract by the Contractor, and shall monthly pay to the Contractor while carrying on the work, the balance not retained as aforesaid, after deducting therefrom all previous payments and all sums to be kept and retained under the provisions of this contract. No such estimate or payment shall be required to be made when, in the judgment of the Engineer, the total value of the work done since the last estimate amount to less than three hundred dollars. Payment may at any time be withheld if the work is not proceeding in accordance with the contract. At the option of the

Board, estimates may be made more frequently and a smaller amount may be retained as aforesaid.

The Engineer shall, as soon as practical after completion of the contract, make a final estimate of the amount of work done under this contract and the value thereof, and the City shall, within sixty days after the final estimate is so made and is approved by the Board, pay the entire sum so found to be due hereunder, after deducting therefrom all previous payments, and all amounts to be kept, and all amounts to be retained under the provisions of this contract. All prior partial payments shall be subject to correction in the final estimate and payment.

ART. XXXVI. Neither the City or the Board, nor any member or agent thereof, shall be liable for, or held to pay, any money to the Contractor, except as provided for in Articles XXXIV and XXXV; and the acceptance of the last payment aforesaid shall operate as, and shall be a release to the City, the Board and any member and agent thereof, from all claim and liability to the Contractor for anything done and furnished for, or relating to, the work, except the claim against the City for the remainder, if any there be, of the amounts kept or retained as provided in Article XXXIII.

IN WITNESS WHEREOF, The parties have hereunto set their hands, in triplicate the ....day of .... in the year 1903.

....

....

....

Board of Sewer Commissioners.

....

....

....

Contractor.

WITNESSES:

....

....

NOTICE.—The surety bond to be given and attached to the copy of the signed contract which the City is to keep, is to specifically state that the same is given to protect the City fully in accordance with all the conditions of a contract entered into by the City and the party named in said surety bond as Contractor, and is to be satisfactory to the said Board of Sewer Commissioners in every way before it will be accepted, and shall also have the approval of the City Corporation Counsel before the same will be accepted by the Board of Sewer Commissioners.

THE PRESIDENT: The next committee is the Committee on Steam and Electric Railroads. Mr. T. C. B. Snell, Chairman.

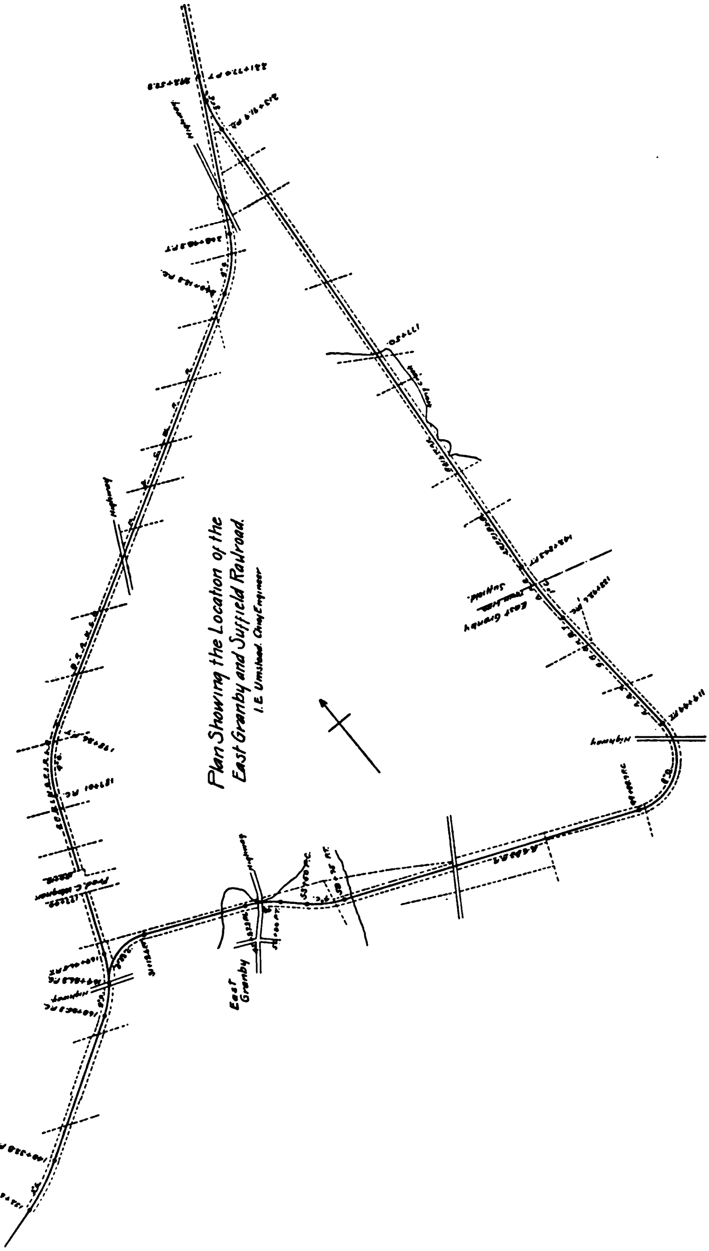
MR. SNELL: Mr. President, I did not bring my report with me as I presumed that, as has been the case before, it would be received and would be printed in the Proceedings. I will see that it is handed to the Secretary.

REPORT OF COMMITTEE ON RAILROADS.

To the President and Members of the Connecticut Society of Civil Engineers:

GENTLEMEN:—In response to the circular letter sent out by the Assistant Secretary in which each member of the Society was invited to state what railroad work had recently been done by him or to his knowledge, this Committee received a total of one reply. This reply was from Mr. E. P. Augur, who reports work on a private railroad for the Benvenue Quarry Co., Maromas, 11,700 ft. being graded, including 25,350 yards of excavation, mostly rock. During the past season track has been laid on about half of this distance, with 74 lbs. rail. The work has all been done by day labor, but the cost is not yet determined.

A railroad has been completed in this State during the past season, the history of which forms one of the most remarkable chapters of Connecticut railroading. To briefly rehearse some well-known facts of recent history, the Hartford and Connecticut Western Railroad Company attempted to build a branch from their main line to Springfield, Mass., by buying the right of way. In this they were opposed by the N. Y., N. H. & H. R. R., who bought the Montague farm, which the proposed branch would cross. The road was built up to the farm on each side, leaving a gap of 313 feet. The legislature failing to give the expected permission to cross this farm, the East Granby and Suffield Railroad Company was formed, and "Loop" around the Montague Farm was built, 3.8 miles long. Mr. I. E. Umstead, Chief Engineer of the East Granby and Suffield Railroad, has kindly sent us the following brief description of the road together with a blue print from which the accompanying map was made.


Plan Showing the Location of the
East Granby and Suffield Railroad.
I.E. Umstead. Chief Engineer
East Granby
Suffield
Highway

East Granby and Suffield Railroad.

"The construction of the East Granby and Suffield Railroad, known as the "Loop around the Montague Farm," was completed in September, 1902. The length is 3.8 miles, while that of the Springfield branch of the Hartford and Connecticut Western Railroad, between the same termini, is 2.4 miles. Its maximum grade is 105.6 feet per mile, this being for 0.4 miles directly after leaving the Springfield branch. The grades are undulating, not exceeding 52.80 feet per mile for the remaining distance.

On the former grade there is a pile trestle 1200 feet long. Each bent has five 40 ft. chestnut piles, capped with 12 x 12 in. timber and the bents are spaced 15 ft. apart. Upon the caps are placed 8 x 16 in. x 30 ft. stringers, on which the ties and rails are laid. A hard underlying stratum of clay was encountered which afforded excellent support for the piling. There is a 27 ft. iron girder (Fig. 1) over the East Granby Highway, Sta. 47 + 32, and a 36 ft. iron girder bridge over Stony Creek at Station 177 + 50 (Fig. 2). Also one 12 ft. and one 15 ft. wooden bridge, at Station 88 + 20 and Station 125 + 35, and a 6 ft. arch culvert at Station 59 + 29 (Fig. 3) over small streams.

The abutments for the bridges as well as the arch culvert are built of concrete of Portland cement, of 1–2–5 proportions. No trouble was experienced in sinking for foundations, as a stratum of hard pan was found at a depth of from four to five feet."

The concrete abutements for the above mentioned bridges, and also the culvert, were built by the Hartford Paving & Construction Company, who have kindly furnished the photographs.

Improved Track in Hartford.

The Hartford Street Railway Company during the past season have replaced their tracks on Main street, Hartford, for a distance of 4861 feet of double track. The section of rail laid, a modification of the ordinary grooved rail, was designed by the company and is known as the Hartford Standard Grooved Rail, P. S. Co., 103-260.

The method of construction adopted is a modification of that

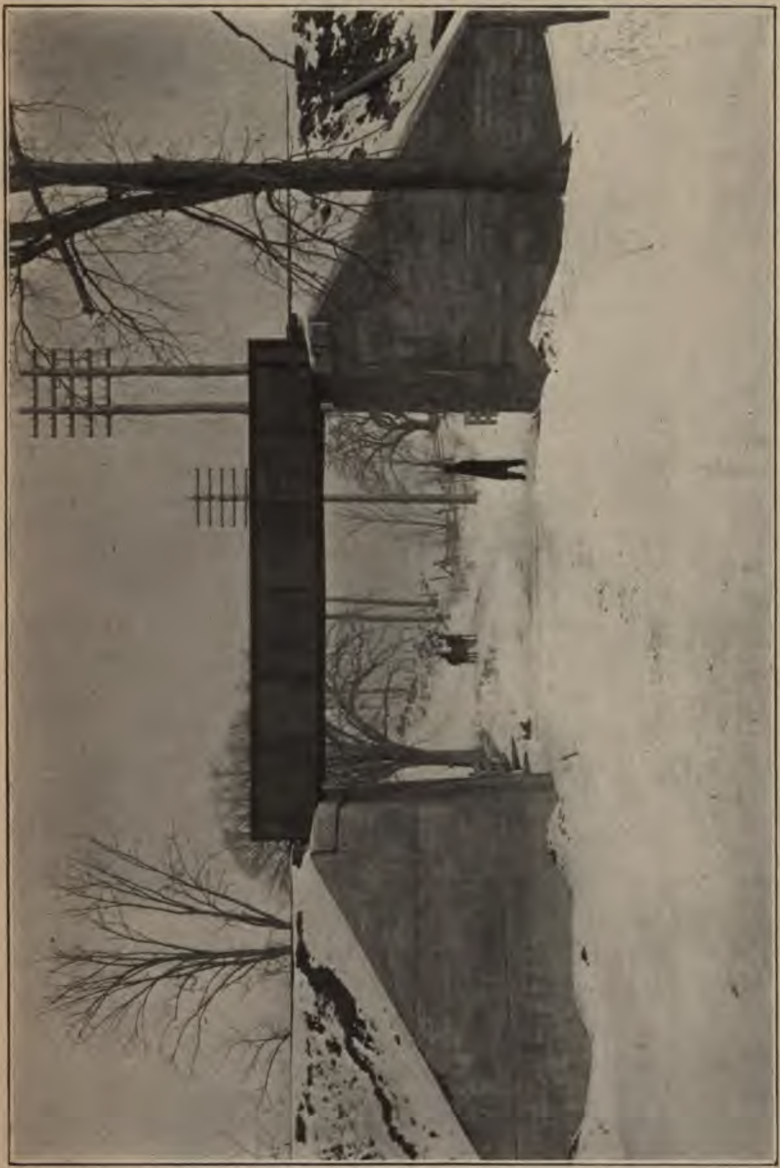


Fig. 1.—Girder Bridge over East Granby Highway.

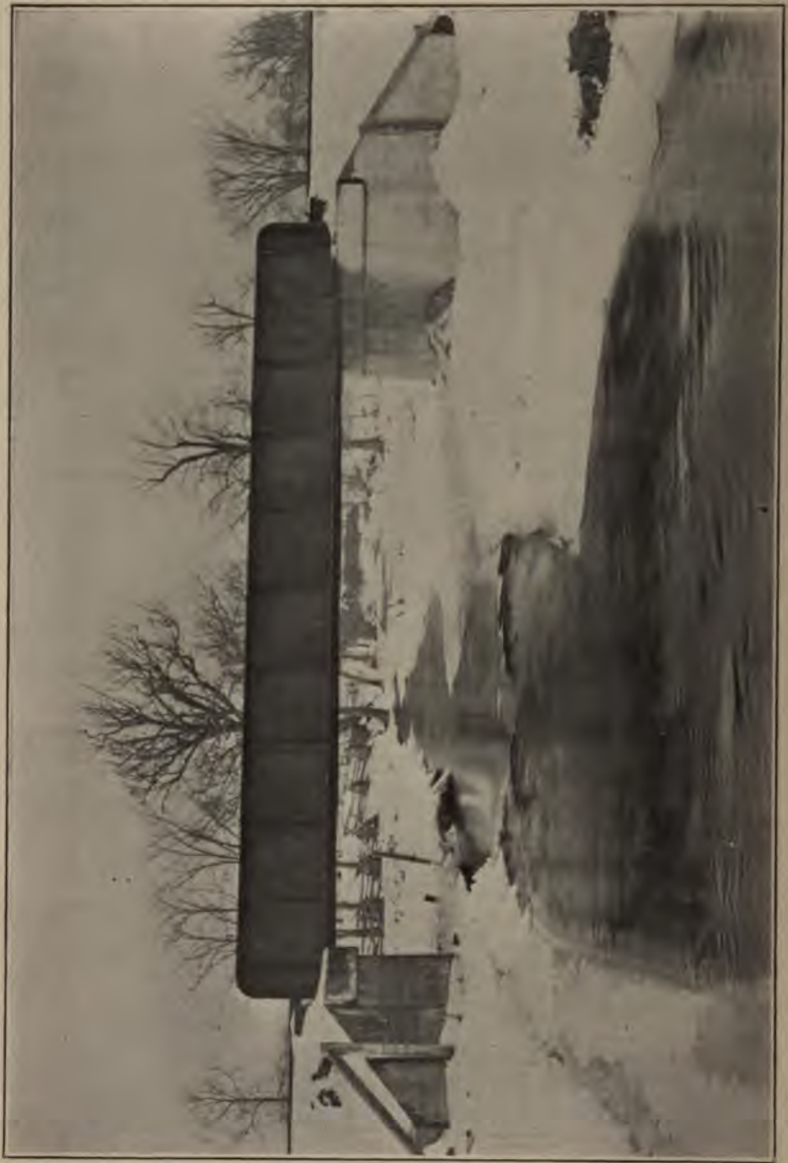


FIG. 2.—Girder Bridge over Stony Creek.

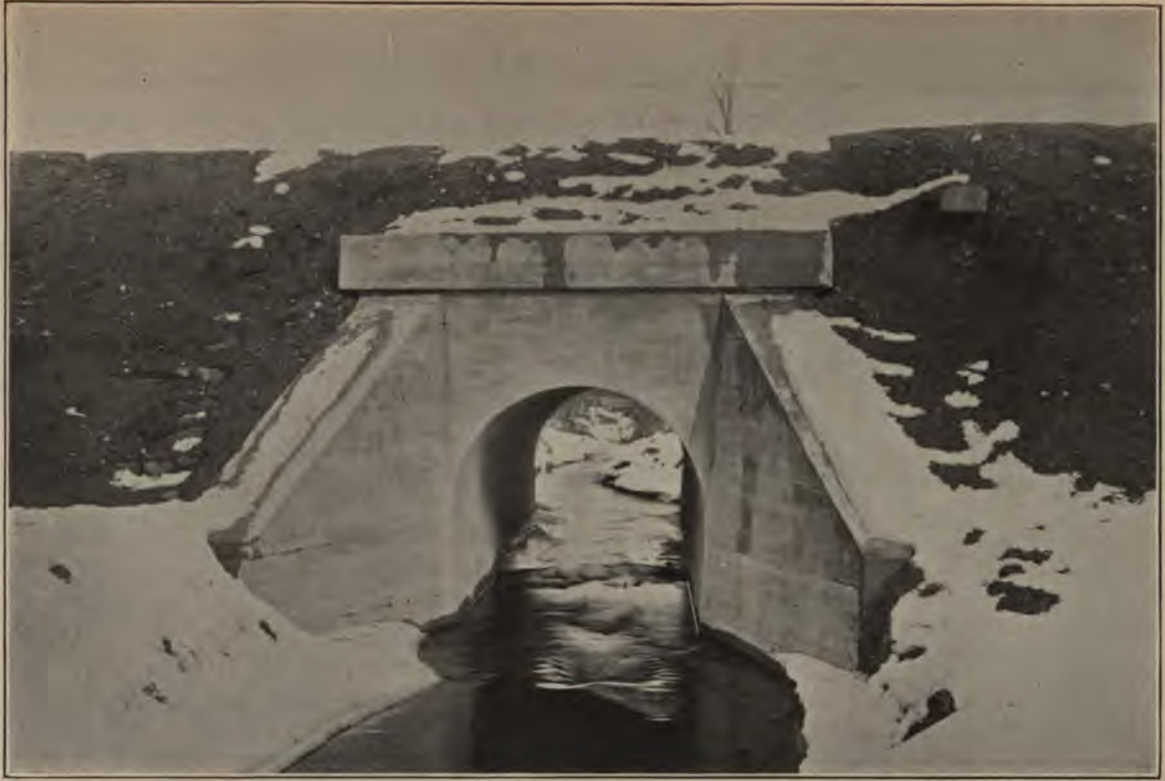


FIG. 3.—Arch Culvert on East Granby and Suffield Ry.

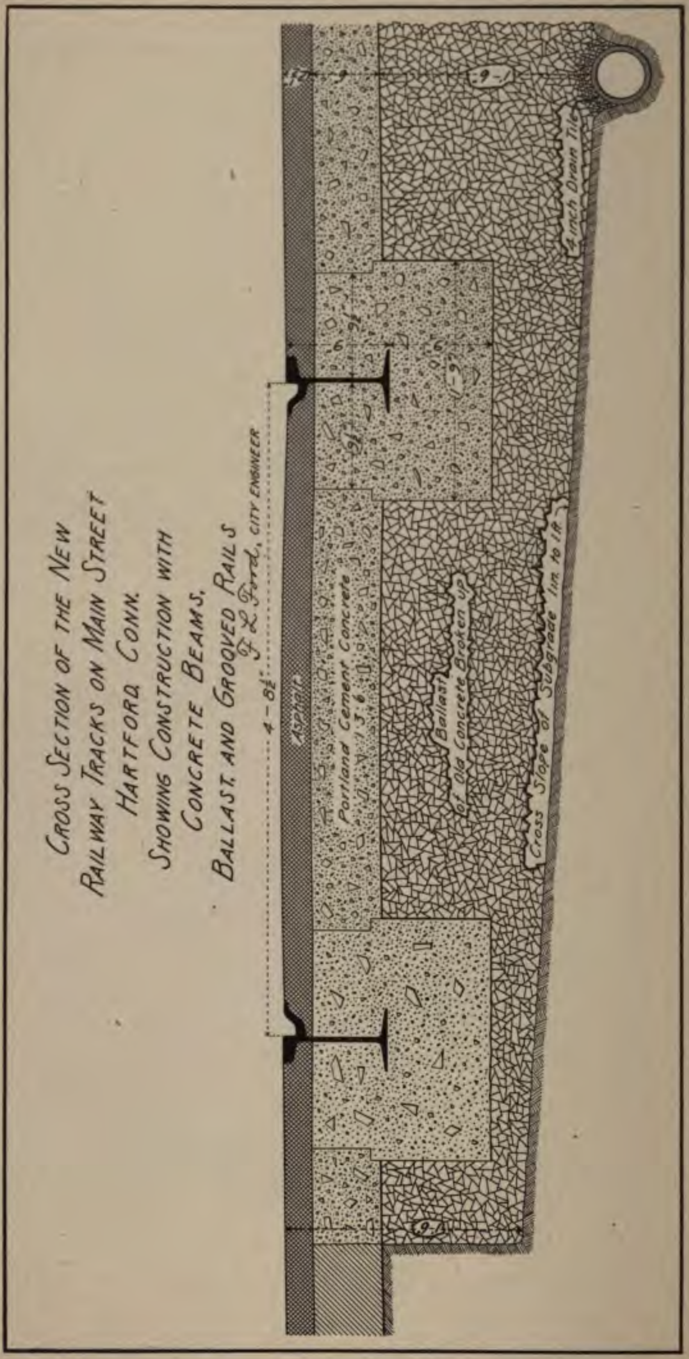

CROSS SECTION OF THE NEW
RAILWAY TRACKS ON MAIN STREET
HARTFORD CONN.
SHOWING CONSTRUCTION WITH
CONCRETE BEAMS,
BALLAST AND GROOVED RAILS
F. L. Ford, CITY ENGINEER
4-8½"
Asphalt
Portland Cement Concrete
1 : 3 : 6
Ballast
of Old Concrete Broken up
Cross Slope of Subgrade 1in. to 1ft.
4 inch Drain Tile
9-1
9
9-1
6
6
9½
9½
1-9

FIG. 4.

known as the Indianapolis method, of concrete girder construction, in which each rail is imbedded in a concrete beam for its entire length. This method is probably the most approved and most substantial construction at the present date for similar locations. The City Engineer, Mr. F. L. Ford, was desirous that provision for draining the street should be made in the sub-grade. Accordingly the track was built as shown in the section, Fig. 4, kindly furnished by Mr. Ford. The sheet asphalt surface was first removed to a width of 18 feet. The concrete foundation thereof was then broken out by picks and sledges, and track and ties removed. The earth was then removed to sub-grade. Only a section of one track was opened up at a time, the traffic being shifted to the remaining track by temporary surface crossovers. For the removal of the material a construction train of flat cars was used, on the abandoned track as long as possible and then on the other track, between cars and at night. The four-inch agricultural tile drain was laid between tracks and graded to sewer manholes, additional ones being built so they would come every 400 or 500 feet. The removed concrete was broken up and replaced in the excavation and additional broken stone was filled in up to bottom of ties, thus making a dry drain under tracks. Sawed ties 6" x 8" x 7" were accurately placed six feet apart, on edge, and the track spiked to them, lined and surfaced. Forms for the concrete girder, exactly 6 ft. long and notched at the lower ends to fit over ties, were placed in vertical position each side of rail and held by bolts with nut on each end, as shown in the photograph, Fig. 5. Portland cement concrete was mixed on the adjacent asphalt pavement in the proportion of 1, 3 and 6, filled into the forms and allowed to set for 48 hours, after which the forms were lifted out and moved ahead. Broken stone was then filled in to the proper height, a six-inch layer of concrete pavement foundation put in, and the asphalt pavement replaced. Fig. 6 shows the concrete girder with forms removed, and a portion of track completed ready for asphalt. The rails were furnished in 60 ft. lengths. The joint plates, which were strongly ribbed, were bolted together with twelve one-inch bolts. All the materials, rails, ties, plates, bolts, spikes, sand, and cement and tile were furnished in place by construction train at night. At each sewer manhole, holes were bored vertically in

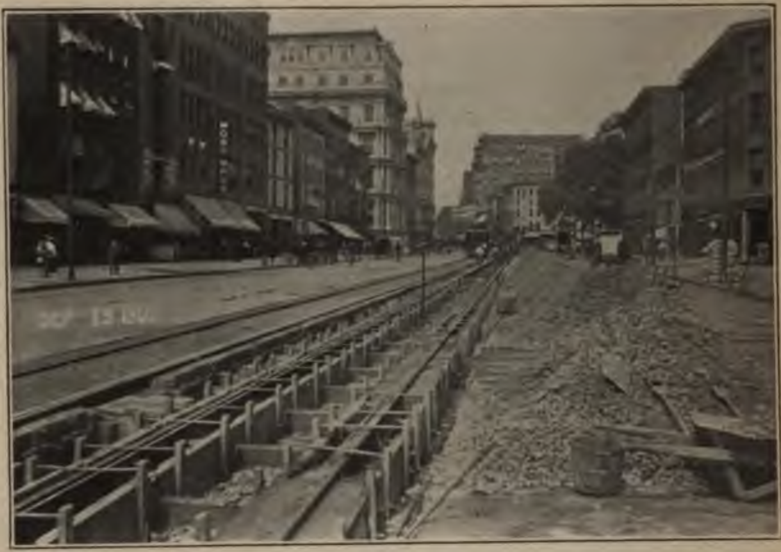


FIG. 5.—Forms for Concrete Girder.

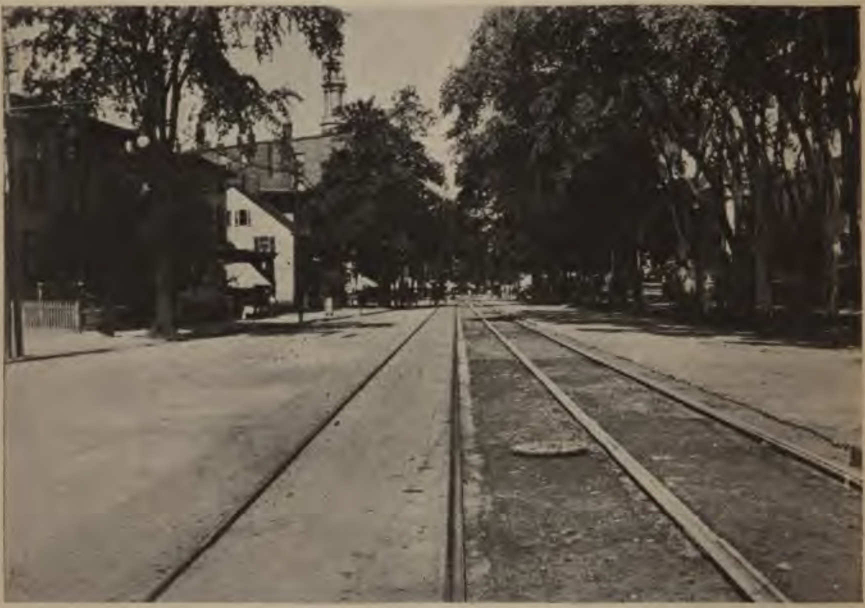


FIG. 6.—Track Ready for Asphalt.

groove of all four rails, and by means of cast iron and tile ducts connection was made to sewer from each rail, thus draining off the water from the grooves.

Before the joint plates were put on the joints were bonded with Washburn and Moen bonds. A machine for forcing the bonds into position was designed by Mr. Frank Caum, Superintendent of the Hartford Street Railway Company, and it was constructed at the shops of the company. This machine was mounted on a light truck, enabling it to be readily moved from joint to joint.

The cost of this work was as follows:

Labor	$21,034.47
Rails, etc.	14,194.12
Special Work	1,572.35
Asphalt (surface only)	18,521.13
Material (for concrete, etc.)	13,246.40
Engineering	587.50
	$69,155.97

Materials furnished were as follows:

Stone, cubic yards	3,686
Portland cement, bbls	3,384
Sand, cubic yards	1,802
Bricks	7,600

The Hartford Street Railway Company is making additions to its equipment at the Power Station on Commerce street. Foundations have been built for a Pennsylvania Steel Works Co., engine direct connected to a General Electrical 1000 K. W. generator. The view, Fig. 7, shows part of these foundations, which are entirely of Portland cement concrete, built in the proportions of 1, 3 and 6. The foundations contain 376 yards of concrete, of which 174 yards are in the lower pressure side of engine, 168 yards in high pressure side and 34 yards in the generator foundation between. The floor and side walls below ground are also concrete, as are the pump foundations shown in lower left-hand corner. Fig. 8 shows these same pump foundations, with bolts in place, and also shows concrete arch openings under fire wall into basement of main station. On the left in Fig. 8, is seen the entrance into the subway, which is a concrete arch 8 feet wide and 7 feet high, and which runs to

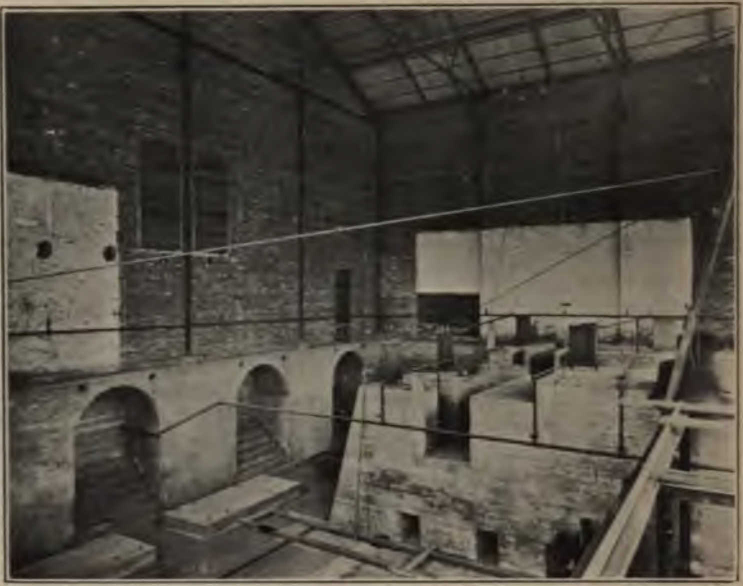


FIG. 7.—Power Station—Foundations for new engines, etc.

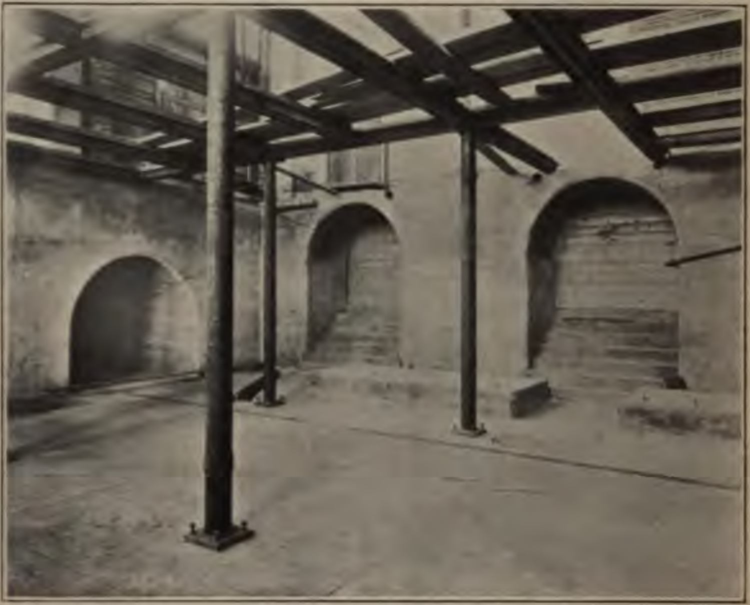


FIG. 8.—Power Station—Floor System and Subway.

the river, a distance of 300 feet. The suction and discharge pipes of the condensers are to be placed in this subway.

This concrete work as shown in the photographs has not been washed down or finished off in any way, except the floor, but is just as it appears when the forms were removed. The exposed surfaces composed of cement and sand mortar, one to one, are built in against the forms at the same time as the rest of the work, and tamped down with it, forming an integral part of the foundation. The concrete work was done by the Hartford Paving and Construction Company.

The floor system for the main floor is shown in both views. The floor beams consist of two old 6″ girder rails, bolted together and separated by a 2″ x 9″ wood spiking piece. Concrete arches will be sprung between the beams and the finish floor of maple will be laid over this and nailed to the spiking pieces.

The Railroad Commissioners report the following track constructed during the year ending with June, 1902.

INCREASE IN MILEAGE.

	Main Track.
Branford Lighting & Water Co. (new)	5.151
Danbury & Bethel St. Ry. Co.	.051
Fair Haven & Westville Railway Co.	.455
Greenwich Tramway Co. (new)	5.568
Hartford & Springfield St. Ry. Co.	4.640
Hartford Street Railway Company	1.096
Suffield Street Railway Company (new)	4.706
	21.667

There has also been an increase in sidings of 2.471 miles.

DECREASE IN MILEAGE.

Conn. Railway & Lighting Co.	.452
Meriden, Southington & Compounce Tramway Co.	.358
	.810

There are now in this State 517.45 miles of street railway tracks, and 26.08 miles sidings. They have increased from 317 miles in 1895, being a growth of sixty-three per cent. and averaging 28 miles a year. There are 1013.35 miles of steam roads in Connecticut, 489.9 miles sidings and 333.43 miles of second, third and fourth track. This has not been increased during the year, except by 6.15 miles of sidings.

The comparative growth of steam and street railways may be seen from the following statement of passengers carried.

	1898.	1899.	1900.	1901.	1902.
Steam Railways	49,835,448	50,269,468	53,352,417	54,235,707	60,045,221
Street Railways	39,272,306	59,084,702	64,109,819	78,222,462	91,554,028

From this it is seen that in 1898-99 the street railways passed the steam roads in number of passengers carried, and that the increase in the steam roads has been 20½ per cent in the five years, while the street railways have increased 133 per cent. The figures given for the steam roads, moreover, are for all the passenger traffic of the four roads on their 2311 miles of track, of which but 1013 are in Connecticut.

Each of these passengers on the steam roads was carried an average distance of 17.35 miles, for which he paid 30.46 cents, the whole amounting to $18,275,183, an increase over last year of 6.6 per cent.

These roads carried 18,730,512 tons of freight during the year, carrying each ton 81.28 miles for $1.18, the whole amounting to $22,088,944, an increase of 9 per cent.

The miles run by all trains were 29,408,520, an increase of 7.6 per cent. The receipts for each of these miles run were $1.99; operating expenses $1.44, leaving net earnings of $0.55. To run these trains the roads have 30,001 employees, 993 locomotives and 16,078 cars.

The street railway revenue for the year was $3,937,771, an increase of 80 per cent. over 1895; and of 9 per cent. over last year. Since 1895 the capital stock has been increased 174 per cent, passengers 140 per cent., taxes paid 220 per cent. The miles run were 19,375,730, being an increase of 6.8 per cent. over previous year; the receipts per mile run were 20.32 cents, operating expenses for same 13.16 cents, leaving a net earning of 7.16 cents. These roads employed 2,903 men and 1,344 cars, of which cars 533 were closed and 629 open passenger cars, 89 snow plows and sweepers, 45 work cars, 36 freight and 11 express cars, and 1 electric locomotive.

SIGNALS.

Recent terrible "accidents" so-called have drawn general attention to the insufficiency of present signal systems on railroads. One chief cause of trouble has been that engineers failed to see or observe danger signals, when same were obscured by fog or smoke, or for other reasons. To overcome this the Miller signal system has been installed in the Park Avenue Tunnel, and on the Chicago and Eastern Illinois system. This signal equipment is exceedingly simple, and entirely automatic, and is in addition to and independent of all the other present existing systems already installed on these roads. It consists of two incandescent lamps, one red and one white, in the cab of the engine, always under the eye of the engineer. One or the other of these lamps is always burning, current being supplied by storage batteries on the engine. If there is a train on either of the two blocks ahead, the current is automatically switched to the red lamp, which burns until the block is clear, when the current is shifted to the white lamp. As installed on the C. & E. I. road the system requires no wires along the track, and the track equipment consists of a single relay instrument and battery to work it.

"Accidents" caused by engineers running by danger signals will continue to occur, and passengers will be slaughtered by the score, as at present, until the railroads are willing to adopt an automatic device for stopping trains which run past red lights. Why such a method has not been adopted long ago, the writer has never been able to understand. Several ways of accomplishing this will occur to anyone, such as a device to automatically open the air brake train pipe. Mr. Willard P. Gerrish of the Harvard Observatory states that, "the patent files are filled with devices for accomplishing this; many of them are entirely practicable. In a few isolated instances they have been used, and used successfully, but they have never met with the general adoption which they deserve." The objection that automatic appliances might lessen watchfulness of engineers could be disposed of by "sealing the stopping mechanism, and imposing a severe penalty if seal is found broken." "No one would think of such a thing as allowing a modern elevator to be dependent entirely on the skill and watchfulness of the operator to prevent it from going through the top of the house. The most carefully planned automatic devices are provided to prevent such occurrences; yet a railroad train, traveling at terrific speed, and representing enormous energy, is allowed to run without any safeguard between itself and disaster, beyond the watchfulness of one man, who may be taken ill, or suffer from a temporary aberration, or may even die suddenly and unnoticed."

The experiment of operating trolley cars equipped with alternating current motors is about to be tried in this country, and a letter describing this innovation by Mr. Robert W. Rollins, member of this Committee, is appended.

Respectfully,
T. C. B. SNELL, *Chairman,*
R. W. ROLLINS,
R. F. STODDARD,
Committee on Railways.

HARTFORD, CONN., February 9, 1903.

Mr. T. C. B. Snell, Chairman Railroad Committee, Connecticut Society of Civil Engineers, Hartford, Connecticut:

DEAR SIR:—The question of electric railroading as viewed from the present standpoint in these days of rapid progress and development of electric transmission is an interesting one.

Referring particularly to the generation, transmission and adaptation of the electric current to car equipments, to-day the greater number of electric roads are supplied with direct current at an E.M.F. of 550 to 600 volts, transmitting this current over long distances with losses in many cases of over 50 per cent.

Confronting this situation, there is a wide field open for future development, which is now attracting considerable attention of our modern electrical engineers.

The Washington, Baltimore and Annapolis Railway extends from suburbs of Washington to Baltimore, a distance of thirty-one miles, with a branch to Annapolis of fifteen miles, which is to be equipped with a system differing entirely from the practice now in vogue, employing single phase alternating currents, transmitting primary currents at 15,000 volts and 2,000 alternations, and lowering this pressure to the trolley wire through substation transformers to 1,000 volts.

There will be nine substations distributed along the railway line, each containing two 250 kilowatt lowering transformers. The current will be supplied to the car equipments through a trolley similar to the present D. C. practice.

The cars are to be equipped with four 100 horse power, single phase motors of approximately 220 volts; a speed of over forty miles per hour will be attained. The motors are series wound with laminated field cores and are operated in two pairs, each consisting of two armatures in series, and two fields in series and two pairs connected in parallel.

The induction controller being applicable to an equipment of this description, enables the use of large currents for heavy traction work, there being no "make and break" contacts.

This single phase apparatus for Washington, Baltimore and Annapolis Railway is to be furnished by the Westinghouse Elec. & Mfg. Co. The equipment is to consist of ten cars and the generating capacity to consist of three 1,500 kilowatt single phase, 15,000 volt machines, running at 83 revolutions; also the necessary lowering transformers at the substations.

In a paper written by Mr. G. B. Lamme and presented at the American Institution of Electrical Engineers, September 26, 1902, a very clear and detailed description of this apparatus was given.

The advent of this alternating current system for railway work must necessarily increase very materially the efficiency of the railway equipments, also eliminating the electrolysis which now exists in railway work. The use of the steam turbine will also bring the system up to the high efficiency now attained by the central stations for lighting and power work. I understand this road will be in operation this coming summer, and will be a system of great interest among railroad men in general.

Very respectfully,

ROBERT W. ROLLINS.

THE PRESIDENT: The next committee is the Committee on Bridges and Masonry. Mr. Ernest W. Wiggin, Chairman.

Mr. Wiggin not being present,

THE PRESIDENT: I think one of the members has some information in regard to bridges that he did not have at the time that the reports were being made up. I believe Mr. Graves has some information on the strength of old timber in bridges which he desires to present.

MR. GRAVES: Mr. President, I am sorry, but I didn't bring it over.

REPORT OF COMMITTEE ON BRIDGES AND MASONRY.

To the President and Members of the Connecticut Society of Civil Engineers:

GENTLEMEN:—Your Committee on Bridges and Masonry respectfully submit the following report:—

Very few bridges have been built in the State during the past year, and with the exception of the work in connection with the abolition of grade crossings at Bridgeport, there is very little bridge work now in process of construction.

The number of highway bridges built has been unusually small and for the minor structures of this class there has been a noticeable increase in the use of concrete. This has undoubtedly been brought about by the high price and uncertain delivery of steel.

The "Yellow Mill Bridge" at Bridgeport, upon which construction was started February, 1901, is now nearly completed. This bridge is about 600 feet long including approaches, and consists of a swing draw span 200 feet long, and five fixed spans of 61′ 6″ with a width of 60 feet between fence lines, and 40 ft. clear roadway.

This bridge was designed to carry the heaviest kind of city traffic. It has a buckle plate floor with brick paving on the roadway and asphalt sidewalks.

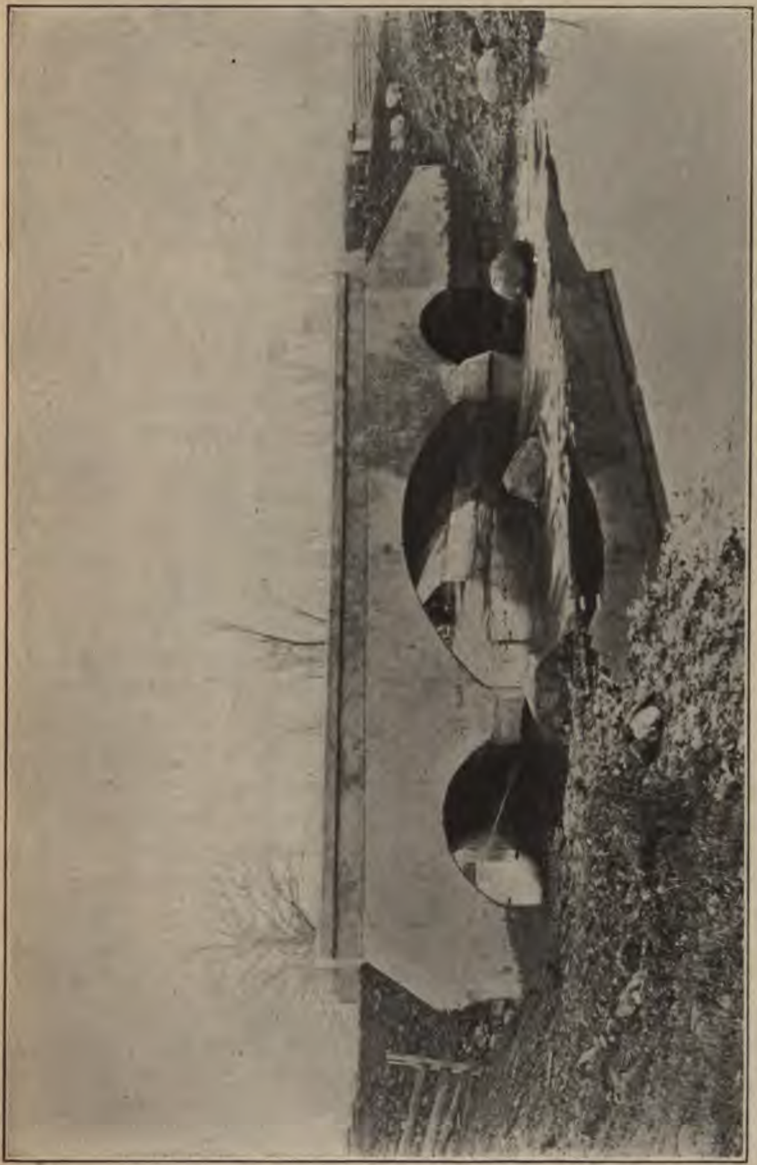
The substructure is concrete below the water line and ashlar masonry above.

The contract price for this structure complete, including masonry, was $147,850.00.

Since erecting the steel work the piers have cracked and settled considerably. The cause of this we have been unable to learn, as there appears to be some difference of opinion among the parties interested.

At Taftville a new highway bridge has been built across the Shetucket River to connect the towns of Norwich and Lisbon. This bridge is 16 feet wide with a plank floor and consists of two spans of 122 feet each.

The masonry cost about $4,700, and the superstructure was built by the Berlin Construction Company for about $5,300.



Fern Street Bridge, Hartford, Conn.

The town of Greenwich has built a new steel highway bridge over the Mianus River, and at North Somers a new plate girder bridge 60 feet long has been erected to carry a 25-ft. highway over the Scantic River.

Two small wooden bridges were replaced by steel and concrete at Norfolk, and at East Lyme two small bridges were constructed,—all for highway purposes. At Waterbury the old wooden bridge which carried Morris Road over the upper end of Wigwam reservoir, has been replaced by a concrete arch of 35 feet clear span.

The arch has 12 feet clear roadway with concrete parapet walls, and cost $3,000.

A new concrete arch of two spans of 10 feet, and one center span of 26 feet, has been built to carry Fern street over Trout Brook at West Hartford. This arch has a total length of 63 feet and a width of 30 feet, containing about 525 cubic yards of Portland cement concrete mixed 1–2–4 for the arch and 1–3–6 for the foundations and spandrel walls.

The very short time in which this structure was completed, together with its reasonable cost, is worthy of notice.

Construction was started October 3d, and completed October 29th, which was 22 working days, making no allowance for bad weather. The work was done by the Hartford Paving and Construction Company, at a total cost of $4,050.

Owing to the failure of the Franklin street bridge at Danbury, a new structure has been erected at that place.

The old bridge, built 12 or 15 years ago, was a stone arch having no foundations below the river bottom. Water getting beneath and back of the abutment caused the west side of the structure to settle. The new bridge consists of plate girders and concrete arches.

A wooden bridge over Five Mile River at Danielson, a 30-ft. plate girder bridge in the vicinity of Waterbury, and a small steel bridge at Killingly, complete the list of highway bridges built in the State during 1902.

In addition to the new bridges mentioned, several structures have been strengthened or otherwise repaired.

The number of railroad bridges actually erected during the year has been below the average, although the amount of railroad bridge work under contract was exceptionally large.

The East Granby and Suffield Railroad built four small steel bridges with concrete abutments and one concrete arch on their famous loop around the Montague Farm.

On the New York, New Haven and Hartford Railroad good progress has been made on the Bridgeport improvement, and the erection of the steel work is now under way.

This improvement, which has been under construction since 1899, will not be completed for some time and properly belongs in some future report, although a brief outline of the work may not be out of place at this time.

The westerly section from Fairfield ave. (west) to Main street, a distance of about 10,500 feet, was completed and opened to travel in February, 1901. On this section the tracks were raised about 14 feet on an earth fill between granite retaining walls, with plate girder bridges over the streets. These bridges are 13 in number, varying from 56 to 94 feet in length, and have a total gross weight of about 1,500 tons. On all these bridges the girders are supported on columns at the curb lines, giving a clear headroom of from 12 to 13 feet at the center of the roadway.

The easterly section, now under construction, was started in 1901, and extends from Main street to Bishop avenue, East Bridgeport, a distance of about 13,100 feet. This section includes the construction of a new passenger station and the elevation of the Berkshire Division track, which connects with the main line at this point.

From South avenue to Union street the tracks will be upon an earth fill between retaining walls. Between these points two inclined tracks will be constructed leading from the freight yard to the new track level. The freight yard being south of the main line, the northerly inclined track will pass under the main line tracks at an angle of 8° 10′.

While the clear span over this track is only 15 feet at right angles, one of the trusses will be 140 feet long and the other 70 feet, the difference in length being due to the curvature of the main tracks.

At Union street there will be a half-through plate girder bridge carrying six tracks. From Union street to the Pequonnock River there will be a steel viaduct of 40 feet deck plate girder span, except at Fairfield avenue (east), where two half-through spans will be substituted to give more headroom over the roadway.

For the five tracks between Union street and Fairfield avenue, and the four main line tracks between Fairfield avenue and the river, the girders will be supported on steel columns, except at every fourth pier, where they will rest directly upon the masonry. The two side-tracks in front of the station will be supported entirely on columns.

On the Berkshire Division, which leaves the main line at a point just west of Fairfield avenue (east), there will be a single track viaduct 1,416 feet long. This will consist of 40-ft. spans of deck plate girders, except at the entrance to the station grounds and at Congress street, where there will be half-through girder bridges of two spans each.

The space between the main line and the Berkshire Division, west of the river, will be utilized for the new passenger station, the elevated platforms of which are to be supported on steel work. The width of the main line viaduct varies from 48 feet center to center of outside tracks near Union street, to 106 feet center to center of outside tracks at the depot, at which point the total width, including platforms, will be about 145 feet. The height from base of rail to top of low piers varies from 11′ 0″ at Union street to 17′ 0″ at the river.

An entirely new four-track bridge will be built over the Pequonnock River about 250 feet south of the present bridge. The draw span is to be a "Scherzer Rolling Lift" of the plate girder type, the first of its kind to be erected in this State, and the second in New England. The west approach will consist of five spans of deck plate girders about 50 feet long, resting on high piers. On the east approach there will be two spans of half-through plate girders, 87′ 10½″ long with double track floor beams. These girders will be 10 feet deep and will weigh about 96,000 pounds each.

On the east side of the river there will be a continuation of the viaduct having half-through girder spans over Sterling street and over Noble avenue and Clarence street, which streets intersect beneath the tracks. The irregular pieces between the river and Sterling street and between Sterling street and Noble avenue are to be deck girders, supported on steel columns.

The steel work ends at the east side of Clarence street, hav-

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TILDEN FOUNDATIONS

g a total length of 3,240 feet of continuous bridging. From is point to Central avenue the tracks are on an earth fill tween retaining walls, and from Central avenue to Bishop enue the new grade is practically the same as the old.

Between Clarence street and Central avenue there are five ate girder bridges over the streets, one of which is for five acks. The general construction of these bridges is the same on the westerly section of the work.

Central avenue, the only highway bridge on the work, is a 0-foot street which will be carried over the tracks on a plate irder bridge of three spans: one center span of 70′, and two pproach spans, one of 37′ 8″, and one of 50′, the approach pans being on a 5 per cent. grade.

Excepting two or three of the river piers, the masonry work as been carried as far toward completion as it is possible to do ntil the steel work for two tracks is erected and traffic removed o the high level.

The steel work is practically all under contract; the material for the draw span and the East Bridgeport bridges is on the ground and erection now under way.

The total estimated weight of the steel work on the easterly section is about 10,700 tons, making a total of 12,200 tons of steel used on this one piece of work, not counting the proposed steel roof or floor work of the new depot.

The viaduct presents no novel features, although the grades and alignment necessitate quite complicated construction in places. At all points where the structure changes from deck to half-through, high piers were built to avoid troublesome details in the steel work.

The rolling lift bridge, a general plan of which is shown in Fig. 1, is probably the most interesting feature of the work.

This is composed of two independent double track bridges which may be operated separately or together.

These bridges are spaced 30′ 6″ center to center, and, with the exception of the operator's house on the fixed span of one, are exact duplicates. The movable portions consist of half-through plate girders 28′ 0″ on centers, having a channel span of 88′ 1″ and a total length of 126′ 4″. These girders are 10 feet deep and were shipped in two sections with a field splice near the ends of the rockers. These rockers are securely riveted to the girders and have circular arcs of 20 feet radius, which roll upon steel track girders embedded in the center pier. The rockers support the entire weight of the lift span, and upon the accuracy of their construction and the careful placing of their supports depend the successful operation of the draw. Fig. 2 is a photograph of the circular section of one rocker ready to be placed in position. Fig. 3 is a view of the bridge with the rockers and rear ends of girders in place. This view also shows the wind bracing between the rockers. The track girders, which are embedded in the pier, together with the bracing between them, are shown in Fig. 4.

The bearing surfaces of the rockers consist of steel castings 2½" thick, which are accurately finished to a true circle and exact radius. The plates and angles to which these are attached were carefully bent and planed while in the web joints of the rocker; great care was taken to insure effective splicing.

The track girders are capped with steel castings upon which there are rectangular blocks or cogs which engage in holes on the faces of the rockers.

The fixed span which supports the operating machinery consists of deck plate girders 54′ 10″ long, resting on steel columns at the center pier.

The lift span is to be operated by electricity.

Each double track bridge is equipped with a 50 h. p. motor for moving the bridge, and a 5 h. p. motor at each end to operate the latches. The channel spans are counterbalanced by cast iron weights bolted to the rear ends of the main girders. These counter weights are so arranged that the bridge is perfectly balanced in a half-open position, although it is practically balanced in all positions as its center of gravity nearly coincides with the center of the rolling circle.

This arrangement requires the ends of the channel spans to be anchored to the rest pier, and results in the minimum expenditure of power for operation.

The power is applied to the bridges by means of operating struts attached to the center of the rolling circles of the rockers. These struts move in a horizontal line and are operated by rack and pinions. The thrust or pull on the fixed spans from these struts is transferred to the track girders in the center pier by means of inclined struts.

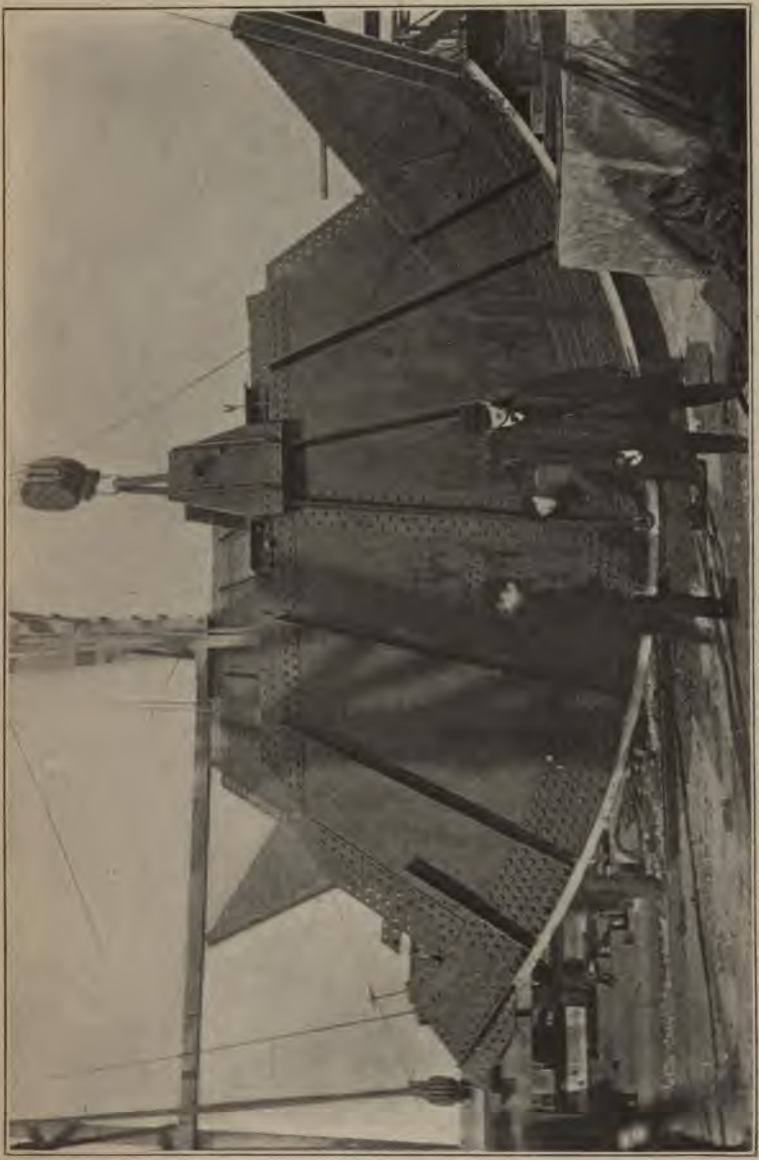


FIG. 2.—Circular Section of Rocker.

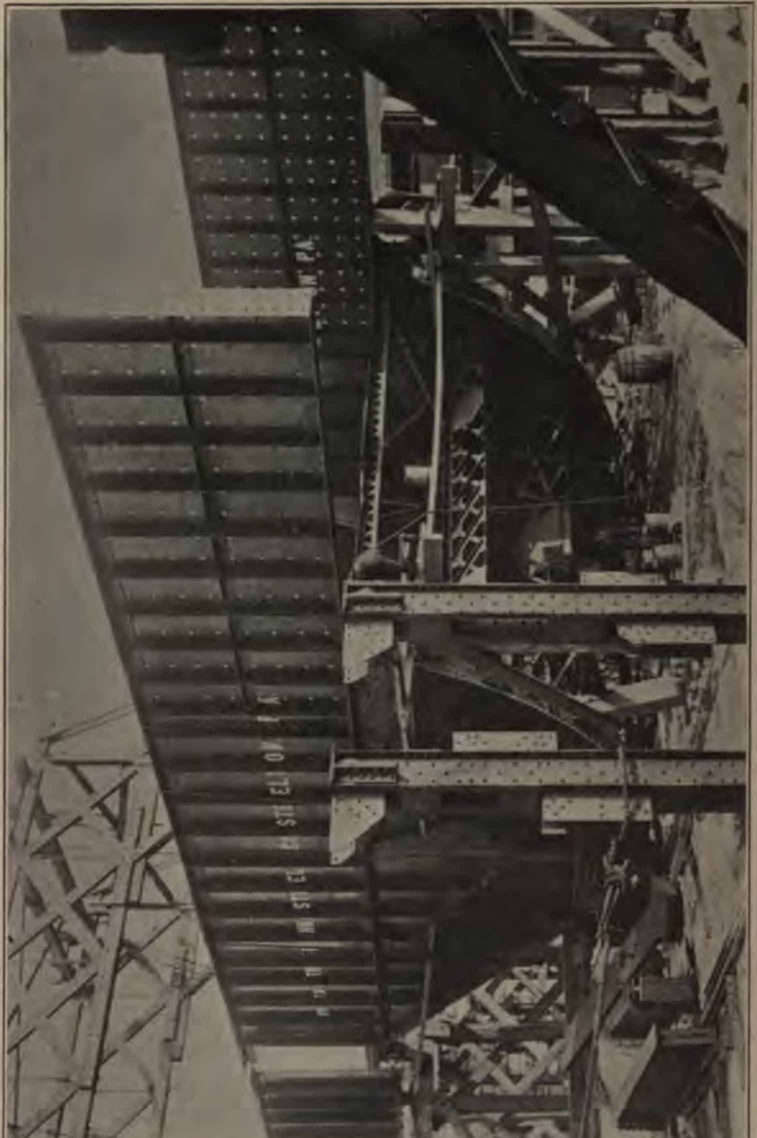


FIG. 3.—Bridge with Rockers and Rear Ends of Girders in place.

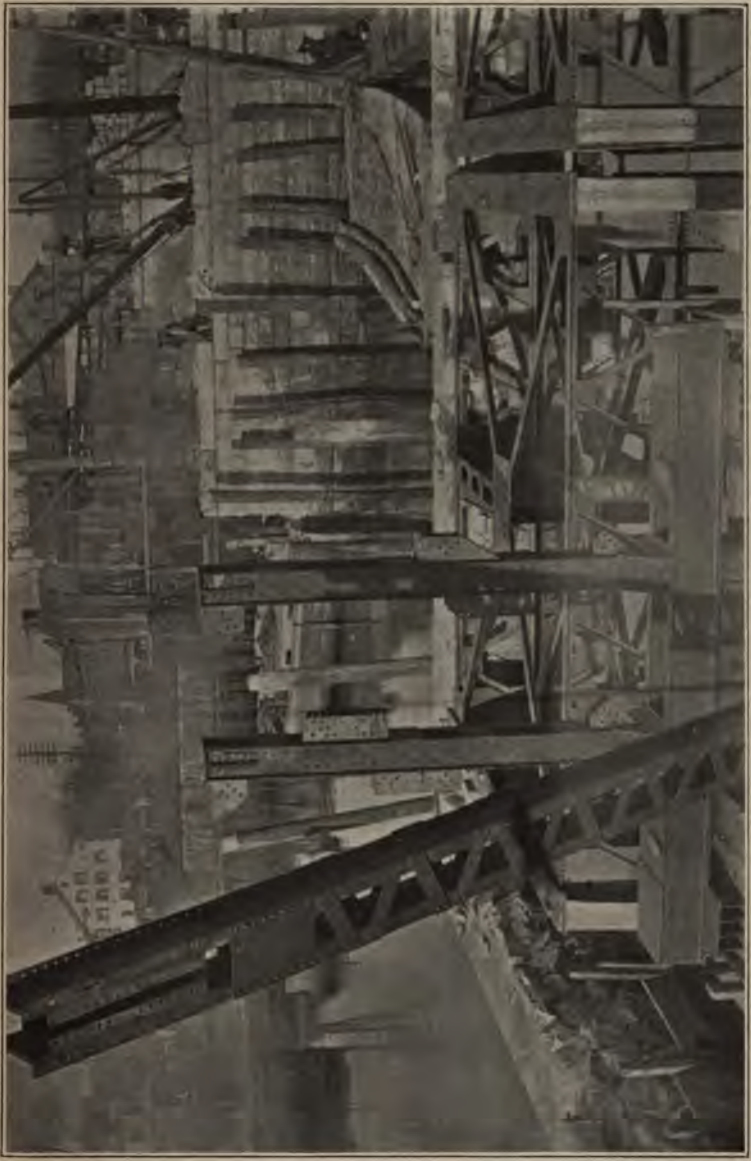


FIG. 4.—Track Girders Embedded in Pier.

The total estimated weight of the Scherzer bridge is about 3,200,000 lbs., and the estimated time for opening or closing, 30 seconds. This bridge was designed by the Scherzer Rolling Lift Bridge Company of Chicago, under the supervision of Mr. W. H. Moore, Engineer of Bridges N. Y., N. H. & H. R. R., and is being built by the Pennsylvania Steel Company of Steelton, Pa.

During the erection of the new draw span, navigation passes through the next span to the east, and the girders which are to span this opening will not be erected until after the draw is in operation and the channel cleared of false work.

The general method of erection can be seen by the accompanying photographs, which we reproduce by courtesy of Mr. J. P. Wagner, Engineer of Construction for the Pennsylvania Steel Co.

Fig. 5 shows the temporary trestle which the Pennsylvania Steel Company built to transport material from the west bank of the river to the draw. The view also shows the piers for the west approach spans. Fig. 6 is a photograph of the traveler, while Fig. 7 and Fig. 8 give a general idea of the bridge and the progress made in its erection.

From Union street to Fairfield avenue (east) the new viaduct will occupy practically the entire width of the right of way, upon which it is necessary to maintain traffic during construction; as the navigable waters of the harbor upon one side, and large buildings upon the other, made it impossible to build temporary tracks which would clear the new work.

Between these points there were, originally, two main line tracks and one siding upon a pile trestle which had been partially filled in.

Upon starting construction, the main line tracks were moved toward the harbor and supported on a pile trestle, while the excavations were made and piles driven for the foundations of the inshore ends of the piers. These ends are of concrete to within about two feet of the grade of the temporary tracks, above which they are to be of ashlar masonry.

Upon the completion of the concrete portion a new trestle was built over this end of the piers, upon which traffic will be carried until part of the viaduct is erected.

The harbor ends of the piers were then built ready to receive the steel work.

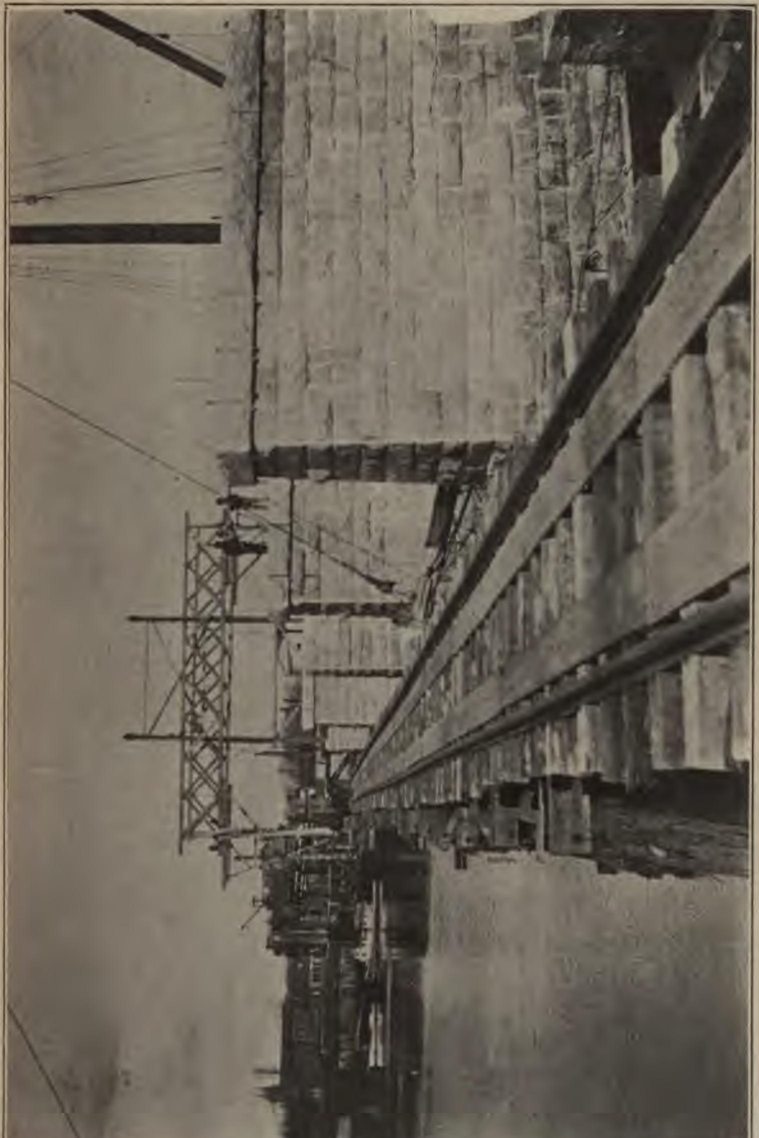


FIG. 5.—Temporary Trestle, with View of Piers for west approach Spans.

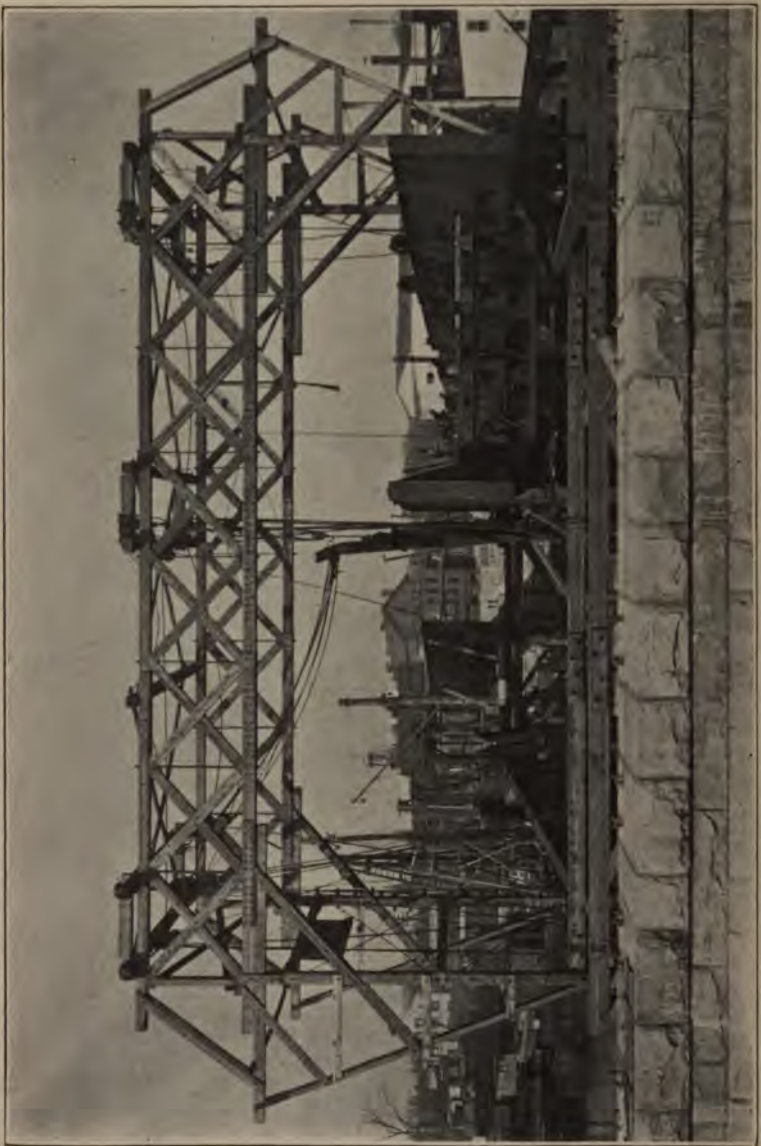


FIG. 6.—Photograph of Traveler.

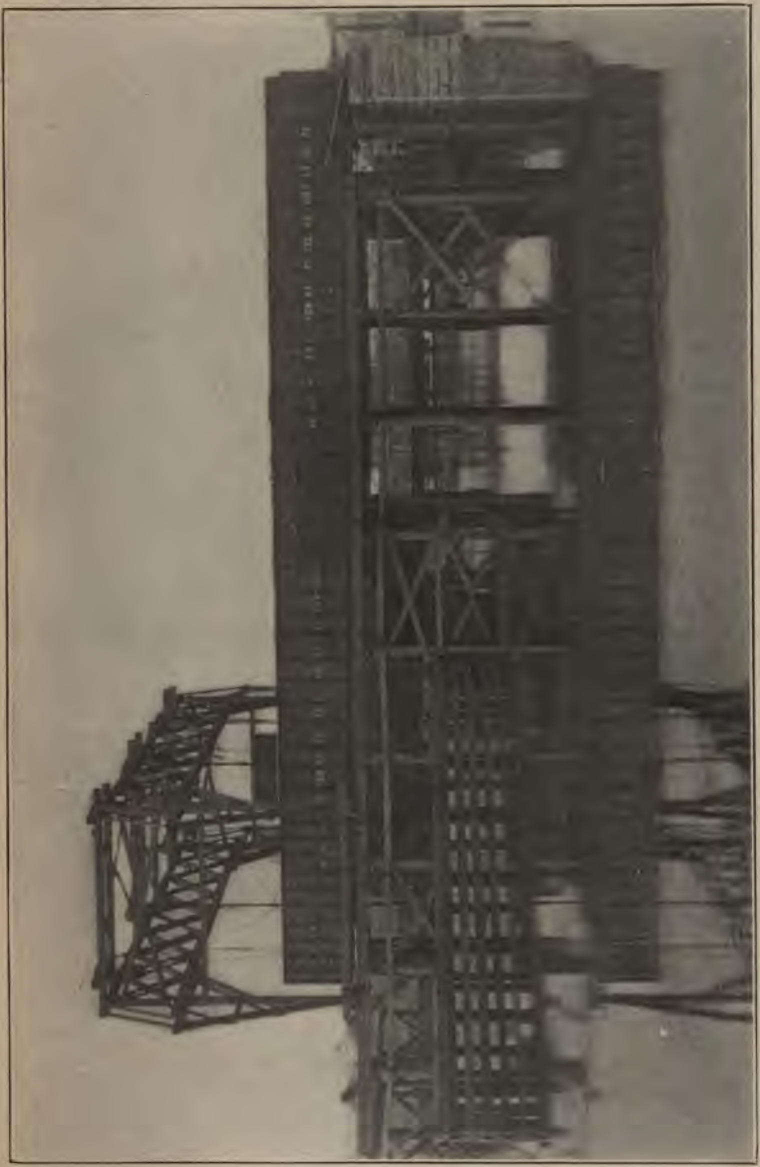


FIG. 7.—General View of Bridge in course of erection.

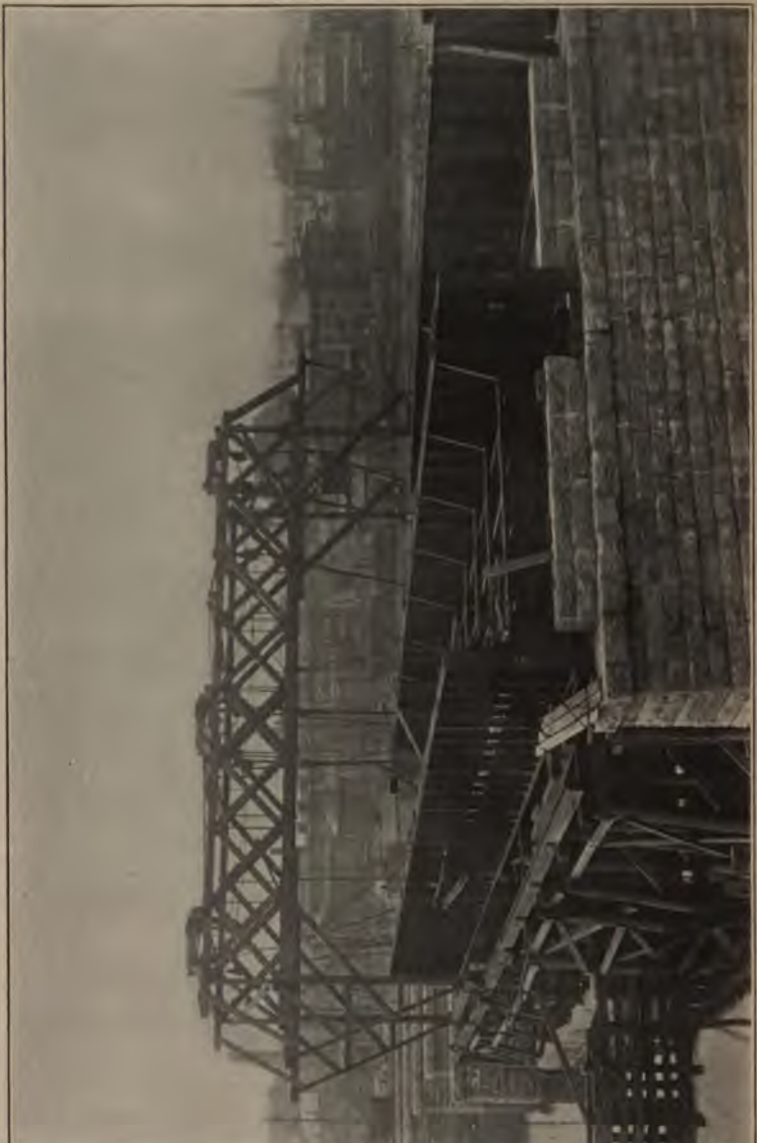


FIG. 8.—View from a different Point.

The shore ends of the piers were built in sheet piling coffer dams, while the deep water at the harbor ends necessitated the use of caissons in most cases. The portion of the piers built in caissons is entirely of ashlar masonry.

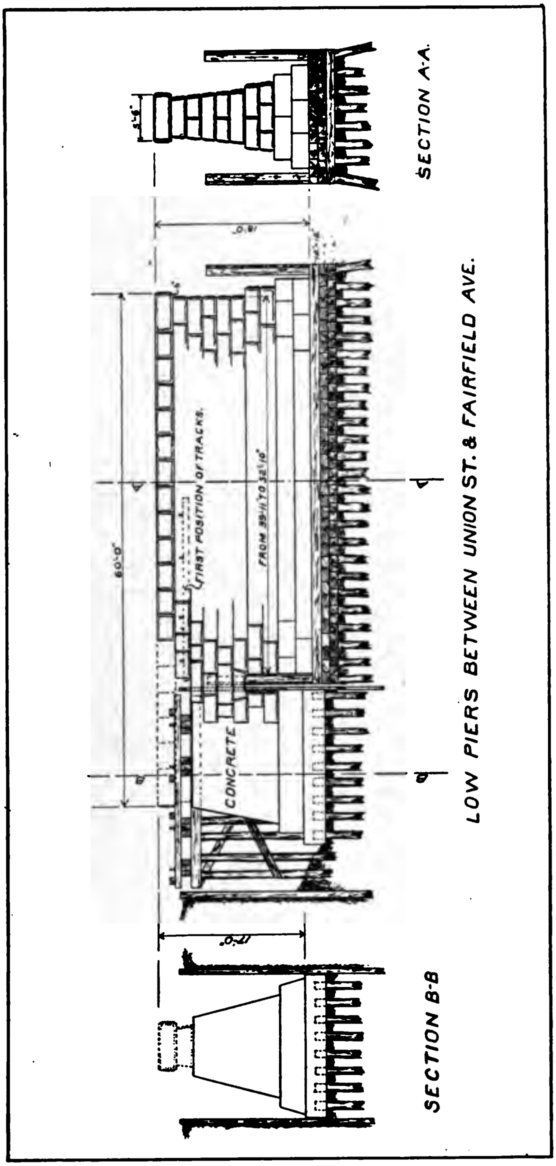


FIG. 9.

The general construction of the low piers, built partly in caissons and partly in coffer dams, can be seen from Fig. 9, which shows the relative part built in each manner and the method of bonding the parts together.

The high piers are of similar construction except the ashlar masonry is carried from six to nine feet higher.

Fig. 9 also shows the temporary positions of the main line tracks.

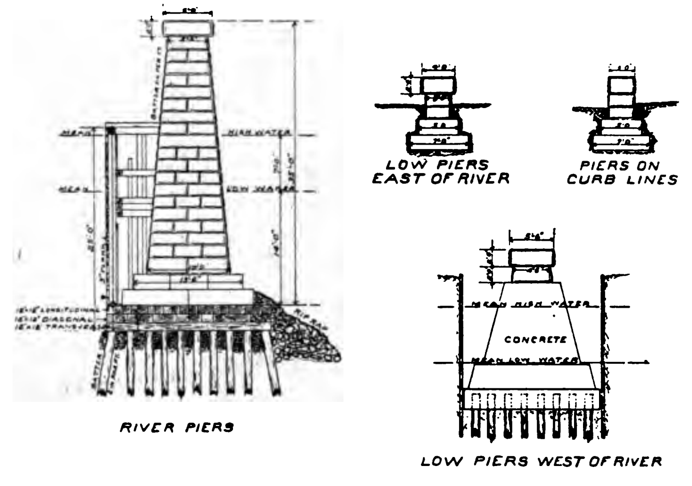


FIG. 10.

Although the interval between trains is very short no trains have been delayed on account of the work.

Between Fairfield avenue and the river the center line of location is a 3° curve, the piers being placed on radial lines. These piers are in three sections; a pier 48 ft. long under the main line tracks, and a pier 13 ft. long under each side-track. Every fourth pier under the main line extends to within 5 ft. 6 in. of the new base of rail, while the remainder are of the type marked "Low Piers West of River" in Fig. 10. All these piers are gravel concrete below ground and granite ashlar above.

The river piers, a typical section of which is shown in Fig. 10, vary from 52′ 0″ to 67′ 6″ in length. These piers are of granite and were built in open timber caissons, a detail of which is shown in Fig. 10.

The center pier for the lift bridge is 80 ft. long by 59 ft. wide, the outside walls of which are of granite 6 ft. in thickness, while the interior is filled with concrete.

This pier was also built in an open caisson which was 93 ft. long by 65 ft. wide, and 29 ft. high. As far as we have been able to learn, this is the largest caisson of its kind ever constructed.

The construction of this caisson was similar to that shown in Fig. 10 except that it was heavier throughout, the bottom consisting of four layers of 12 x 12 timber, and a more extensive system of interior bracing was needed to give the necessary rigidity.

The low piers east of the river and the piers upon the curb lines of the isolated streets are shown in Fig. 10.

West of the river nearly all the piers are upon piles which were cut off well below low water line.

The masonry of the Berkshire Division is similar to that of the main line.

The river bottom is a soft, black mud of great depth, which material was encountered a short distance below the surface a greater part of the way to Fairfield avenue. Near Fairfield avenue the soil was of sufficient stability to support the masonry, as apparently a small neck of land originally extended into the harbor at this point. Mud of considerable depth was found between Fairfield avenue and Union street, which, with the close proximity of building foundations, necessitated great care in making excavations for the new piers.

The stone masonry throughout the work is of granite, a large proportion of which came from the Mine Hill Quarries. All concrete was mixed in the proportion of 1-3-6, gravel being used in place of broken stone.

The bridges and viaduct were designed under the supervision of Mr. W. H. Moore, M. Am. Soc. C. E., Engineer of Bridges, N. Y., N. H. & H. R. R., while the substructure was designed and all construction carried on under the direction of Mr. R. M. Berrian, M. Am. Soc. C. E., Engineer of Construction, N. Y., N. H. & H. R. R.

The principal contractors for the steel work are the American Bridge Co., and the Pennsylvania Steel Co., while Holbrook, Cabot & Rollins, and the O'Brien Construction Co. are the contractors for the masonry.

In addition to the Bridgeport improvement the N. Y., N. H. & H. R. R. has started work on the double tracking of the Naugatuck Division between Naugatuck Junction and Ansonia. In connection with this work there will be a change of location between Derby Junction and Ansonia necessitating the construction of two large steel bridges over the Naugatuck River, also several plate girder bridges and a large quantity of wooden trestle. The construction of the substructure for these bridges is well under way and the steel work will probably be erected during the coming summer.

At Waterbury, on the Naugatuck Division, a small I beam bridge was rebuilt and an old Howe truss of one span replaced by two spans of half-through plate girders 55 ft. long.

At Stevenson, on the Berkshire Division, an 8-ft. arch was built at the bottom of the ravine and the large wooden trestle filled in. This trestle was about 700 ft. long and 67 ft. high at the highest point, and about 280,000 yds. of gravel were required to fill it.

A small I beam span was erected at Shelton, and the replacing of two wooden structures near Derby by modern steel bridges is now under way. At Plainville, on the Northampton Division, and at Grosvenordale, on the Norwich Division, old iron bridges are being removed and steel structures erected.

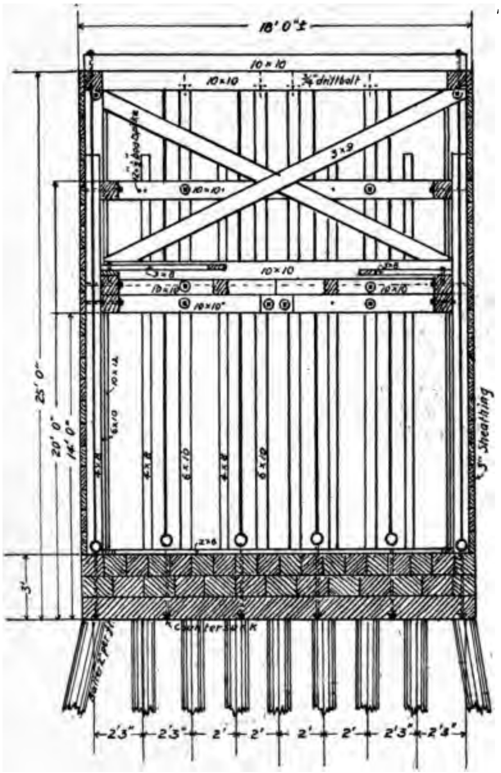
A covered steel footbridge has been built over the tracks to connect the passenger stations at Stamford.

The above mentioned work covers all the bridge and bridge masonry construction in the State which has come to our notice. Regarding masonry other than bridge masonry we have nothing to offer, being unable to obtain information of any work of interest.

ERNEST W. WIGGIN,
Chairman.

[illegible]

CAISSON for RIVER PIERS Bridge no. 100
Piers. A.B.C.&D.(& I.) Piers F.& H. 1' to 2' wider.
Pequonnock River
Bridgeport
Scale ¼" = 1'



Cross Section

Note: Top Floor to be fastened to Middle Floor with ⅞" sq. drift bolts, 18" long, one at each intersection. Middle to Bottom Floor the same.
Sheathing fastened with 6" cut spikes: seams calked with oakum
All bolts ¾" round.

The President: The next is the Committee on Highway Construction and Pavements. Is Mr. Wilcox here?

Mr. R. M. Wilcox: Mr. President, I have the report ready and I will be glad to submit it.

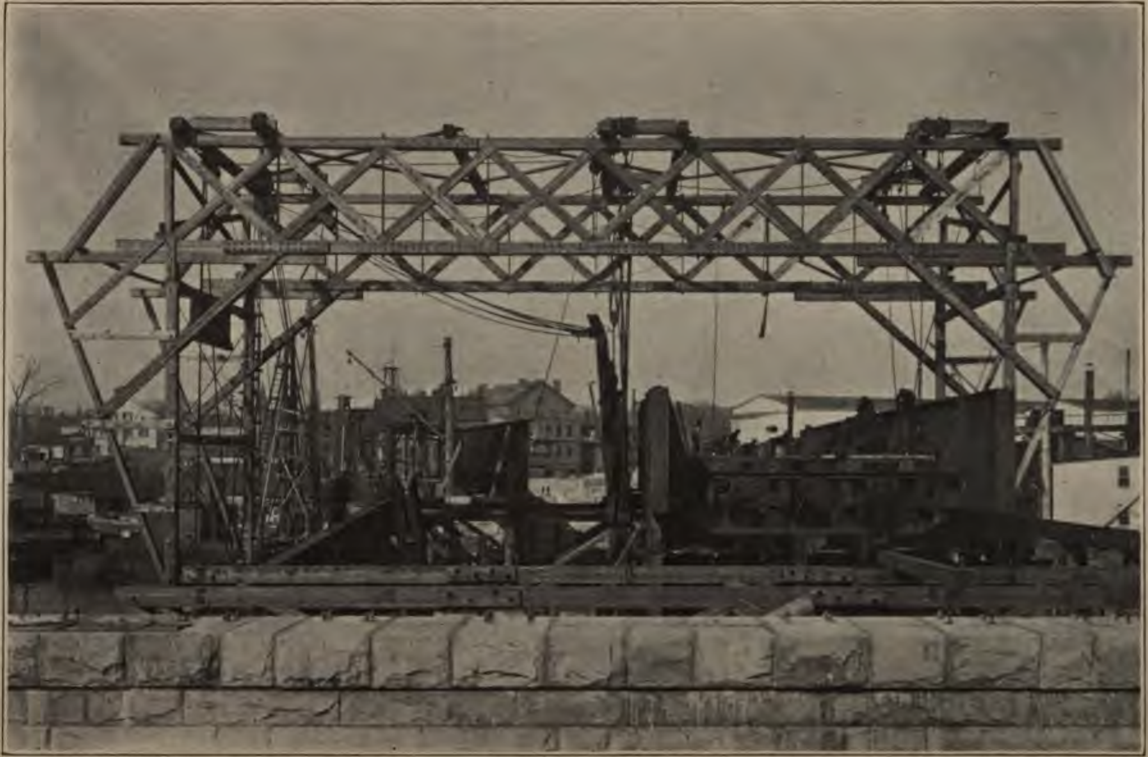


FIG. 6.—Photograph of Traveler.

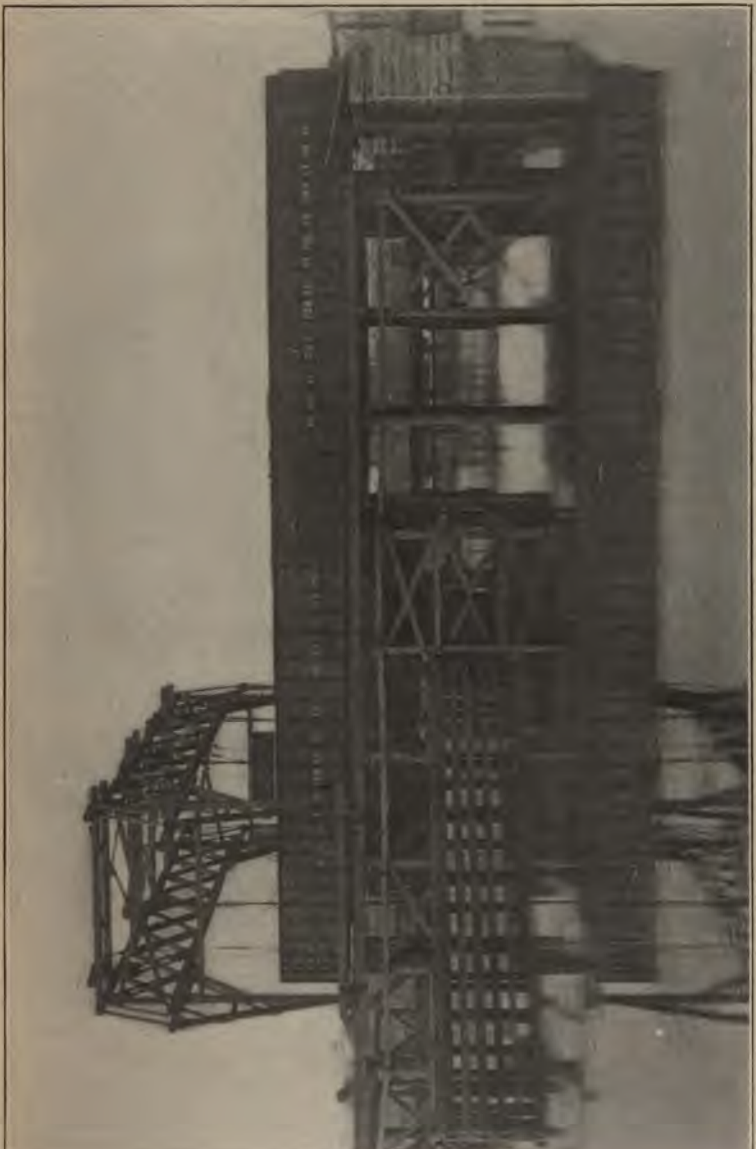


FIG. 7.—General View of Bridge in course of erection.

is submitted. This system has been developed, arranged and used in the city engineer's office at Middletown for the past three years, and has given excellent results.

By examination, it will be noticed that the difference between the values for the left and right-hand stake for elevation, rod reading and stake mark are the same for the same station. This gives a triple check on the work of giving grade marks on stakes; thus practically eliminating all chance of error except in rod reading. If this is done by both leveler and rodman there need not be much fear of mistakes.

We take pleasure in presenting in our report a series of tables for use in giving grades on pavement work, prepared and presented by Mr. H. H. Gladding, Assistant City Engineer, in charge of street work of New Haven. Those who may have occasion to lay out work of this nature will no doubt appreciate its value as an aid to accuracy as well as a great saving of time and labor.

Respectfully submitted,
R. M. WILCOX,
FRANK N. HOYT,
Committee on Highway Construction and Pavements.

TABLE SHOWING METHOD OF KEEPING LEVEL NOTES IN WORK OF SETTING GRADE STAKES.

Station.	Grade.	Stake Elev.		B. S.	H. I.	Rod Reading.		F. S.	Stake Mark.		Remarks.
		Left.	Right.			Left.	Right.		Left.	Right	
....	....	....	....	7.423	147.423	..	..	....	....	....	B. M. Elev. = 140.000
2800	139.5	142.2	142.3	....	....	5.2	5.1	1.166	−2.7	−2.8	T. P. Elev. = 146.257
2850	142.0	146.5	147.0	6.500	152.757	6.3	5.8	....	−4.5	−5.	
2900	143.8	148.1	149.3	....	....	4.7	3.5	....	−4.3	−5.5	
2950	145.3	148.8	148.2	....	....	4.0	4.6	....	−3.5	−2.9	
3000	146.0	147.6	150.7	....	....	5.2	2.1	....	−1.6	−4.7	

MUNICIPAL STREET IMPROVEMENT AND PAVEMENT TABLE.

CITY OR BOROUGH.	Kind of Treatment.	Length of Street.	Width between Curbs.	Depth Treatment.	Area in Square Yards.	Cost of Grading.	Cost of Treatment.	Cost of Entire Work.	Total Cost per sq. yd., Contract.	Remarks.
Bridgeport......	Brick	1,650'.0	33'	11½"	8,946				$2.46	Porter wire cut—6" concrete, 1½" sand, 4" brick.
Bridgeport......	Macadam			6"					.65	
Meriden	Macadam		34'	6"	4,761 Macadam 370 gutters		$2,569.18		.50	Total cost, including surface water pipes, $4,356.66.
Meriden	Stone and gravel		30'	6"	9,366			$2,136.95	.228	Includes laying of cobble gutters.
Meriden	Repairing Macadam							1,685.		
Middletown:										
(Lincoln st.)...	Macadam	750'	36'	8"		$ 60.00	1,316.71		$0.439	
(Berlin st.)....	"	500	36	8"		399.46	1,000.00		.50	Cost of corner curbs ($228.55).
(Berlin st.)....	"	800	20	8"		500.00	845.00		.48	
(Main st.).....	"	505	36	4"		128.22	500.50		.247	Resurfacing and Picked up.
(E. College st.)	"	724	21	3"			323.17		.20	Resurfacing and not Picked up.
(Center st.)....	"	720	20	4"		90.00	379.74		.237	Resurfacing and Picked up.
New Haven.....	Vitrified brick paving with concrete foundation	3,135	30	11"	10,341			28,410.02	$2.495	
New Haven.....	Crushed stone paving	2,770	24.5	6"	7,854			5,959.13	0.56	
Torrington:										
(N. Main st.)..	Macadam	3,629	30	8"–10"	5,040.3			3,784.27	.758	Cost includes grading.
(Pearl st.).....	"	500	25	8"–10"	1,388.8				.60	Cost includes grading.
(Prospect st.)..	"	200	25	8"–10"	555.5				.60	Approximate.
(N. Main st.)..	Grading and gravel	683.5	50					1,690.07	.45	Approximate.
(Pythian av.)..	Grading and gravel	221.	40					547.41	55	Includes turfing and damages.
(N. Elm st.)...	Grading and gravel	169.1	42					418.85	.53	Cut .1'–4'.0'.
(E. Elm st.)...	Grading and gravel	1,301.2	42					3,076.	.53	Fill .1–3.5'.
(Winthrop st.).	Grading and gravel	345.	40					854.50	.55	
Waterbury	Vitrified brick				3,350			7,598.	2.26	
Waterbury	Granite Block				2,871			7,673.	2.60	

The table of simple parabolic curves having a total drop of one inch per foot is intended merely to facilitate the calculation of such other similar curves as may be desired for practical use. Thus, to obtain a curve whose total drop is ⅜ inch per foot, multiply the vertical ordinates given by the fraction ⅜.

Observe that in this printed table the vertical ordinates are in inches and decimals. By shifting the decimal points in these ordinates one place to the left, we have a new set of curves, whose total drop is one-tenth of a foot per foot, the vertical ordinates being in feet and decimals: multiplying these new vertical ordinates by $\frac{.027}{.1}$, $\frac{.03}{.1}$, $\frac{.04}{.1}$ etc., we obtain other curves whose total drop is .027 feet per foot, .03 feet per foot, .04 feet per foot, etc., the vertical ordinates being in feet and decimals.

Simple Parabolic Curve:—Total Drop=1 inch per Foot.

0	2.3	3	5′						
	1.06	1.80	5.00″						
0	2	3	3.3	4	6′				
	0.67	1.50	1.82	2.67	6.00″				
0	2	3	4	4.3	5	7′			
	0.57	1.29	2.29	2.64	3.57	7.00″			
0	2	4	5	5.3	6	8′			
	0.50	2.00	3.13	3.51	4.50	8.00″			
0	2	4	5	6	6.3	7	9′		
	0.44	1.78	2.78	4.00	4.41	5.44	9″		
0	2	4	6	7	7.3	8	10′		
	0.40	1.60	3.60	4.90	5.33	6.40	10″		
0	2	4	6	7	8	8.3	9	11′	
	0.36	1.45	3.27	4.45	5.82	6.26	7.36	11″	
0	2	4	6	8	9	9.3	10	12′	
	0.33	1.33	3.00	5.33	6.75	7.21	8.33	12″	
0	2	4	6	8	9	10	10.3	11	13′
	0.31	1.23	2.77	4.92	6.23	7.69	8.16	9.31	13″
0	2	4	6	8	10	11	11.3	12	14′
	0.29	1.14	2.57	4.57	7.14	8.64	9.13	10.29	14″
0	3	6	9	11	12	12.3	13	15′	
	0.60	2.40	5.40	8.07	9.60	10.09	11.27	15″	
0	3	6	9	12	13	13.3	14	16′	
	0.56	2.25	5.06	9.00	10.56	11.06	12.25	16″	

0	3	6	9	12	13	14	14.3	15	17′			
	0.53	2.12	4.76	8.47	9.94	11.53	12.03	13.24	17″			
0	3	6	9	12	14	15	15.3	16	18′			
	0.50	2.00	4.50	8.00	10.89	12.50	13.00	14.22	18″			
0	3	6	9	12	15	16	16.3	17	19′			
	0.47	1.89	4.26	7.58	11.84	13.47	13.98	15.21	19″			
0	3	6	9	12	15	16	17	17.3	18	20′		
	0.45	1.80	4.05	7.20	11.25	12.80	14.45	14.96	16.20	20″		
0	3	6	9	12	15	17	18	18.3	19	21′		
	0.43	1.71	3.86	6.86	10.71	13.76	15.43	15.95	17.19	21″		
0	3	6	9	12	15	18	19	19.3	20	22′		
	0.41	1.64	3.68	6.55	10.23	14.73	16.41	16.93	18.18	22″		
0	3	6	9	12	15	18	19	20	20.3	21	23′	
	0.39	1.56	3.52	6.26	9.78	14.09	15.70	17.39	17.92	19.17	23″	
0	3	6	9	12	15	18	20	21	21.3	22	24′	
	0.37	1.50	3.38	6.00	9.38	13.50	16.67	18.38	18.90	20.17	24″	
0	3	6	9	12	15	18	21	22	22.3	23	25′	
	0.36	1.44	3.24	5.76	9.00	12.96	17.64	19.36	19.89	21.16	25″	
0	3	6	9	12	15	18	21	22	23	23.3	24	26′
	0.35	1.38	3.11	5.54	8.65	12.46	16.96	18.62	20.35	20.88	22.15	26″
0	3	6	9	12	15	18	21	23	24	24.3	25	27′
	0.33	1.33	3.00	5.33	8.33	12.00	16.33	19.59	21.33	21.87	23.15	27″
0	3	6	9	12	15	18	21	24	25	25.3	26	28′
	0.32	1.29	2.89	5.14	8.04	11.57	15.75	20.57	22.32	22.86	24.14	28″

SIMPLE PARABOLIC CURVE:—TOTAL DROP = 1 INCH PER FOOT.

0	3 0.31	6 1.24	9 2.79	12 4.96	15 7.76	18 11.17	21 15.21	24 19.86	25 21.55	26 23.31	26.3 23.85	27 25.14	29′ 29″		
0	3 0.30	6 1.20	9 2.70	12 4.80	15 7.50	18 10.80	21 14.70	24 19.20	26 22.53	27 24.30	27.3 24.84	28 26.13	30′ 30″		
0	3 0.29	6 1.16	9 2.61	12 4.65	15 7.26	18 10.45	21 14.23	24 18.58	27 23.52	28 25.29	28.3 25.84	29 27.13	31′ 31″		
0	3 0.28	6 1.13	9 2.53	12 4.50	15 7.03	18 10.13	21 13.78	24 18.00	27 22.78	28 24.50	29 26.28	29.3 26.83	30 28.13	32′ 32″	
0	3 0.27	6 1.09	9 2.45	12 4.36	15 6.82	18 9.82	21 13.36	24 17.45	27 22.09	29 25.49	30 27.27	30.3 27.82	31 29.12	33′ 33″	
0	3 0.26	6 1.06	9 2.38	12 4.23	15 6.62	18 9.53	21 12.97	24 16.94	27 21.44	30 26.47	31 28.27	31.3 28.82	32 30.12	34′ 34″	
0	3 0.26	6 1.03	9 2.31	12 4.11	15 6.43	18 9.26	21 12.60	24 16.46	27 20.83	30 25.71	31 27.46	32 29.26	32.3 29.81	33 31.11	35′ 35″
0	3 0.25	6 1.00	9 2.25	12 4.00	15 6.25	18 9.00	21 12.25	24 16.00	27 20.25	30 25.00	32 28.44	33 30.25	33.3 30.80	34 32.11	36′ 36″
0	3 0.24	6 0.97	9 2.19	12 3.89	15 6.08	18 8.76	21 11.92	24 15.57	27 19.70	30 24.32	33 29.43	34 31.24	34.3 31.80	35 33.11	37′ 37″
0	3 0.24	6 0.95	9 2.13	12 3.79	15 5.92	18 8.53	21 11.61	24 15.16	27 19.18	30 23.68	33 28.66	34 30.42	35 32.24	35.3 32.79	36 34.11	38′ 38″
0	3 0.23	6 0.92	9 2.08	12 3.69	15 5.77	18 8.31	21 11.31	24 14.77	27 18.69	30 23.08	33 27.93	35 31.41	36 33.23	36.3 33.79	37 35.10	39′ 39″
0	3 0.23	6 0.90	9 2.03	12 3.60	15 5.63	18 8.10	21 11.03	24 14.40	27 18.23	30 22.50	33 27.23	36 32.40	37 34.23	37.3 34.78	38 36.10	40′ 40″

SIMPLE PARABOLIC CURVE:—TOTAL DROP=1 INCH PER FOOT.

0	3	6	9	12	15	18	21	24	27	30	33	36	37	38	38.3	39	41′			
	0.22	0.88	1.98	3.51	5.49	7.90	10.76	14.05	17.78	21.95	26.56	31.61	33.39	35.22	35.78	37.10	41″			
0	3	6	9	12	15	18	21	24	27	30	33	36	38	39	39.3	40	42′			
	0.21	0.86	1.93	3.43	5.36	7.71	10.50	13.72	17.35	21.43	25.93	30.86	34.38	36.22	36.77	38.10	42″			
0	3	6	9	12	15	18	21	24	27	30	33	36	39	40	40.3	41	43′			
	0.21	0.84	1.88	3.35	5.23	7.53	10.26	13.40	16.95	20.93	25.33	30.14	35.37	37.21	37.77	39.09	43″			
0	3	6	9	12	15	18	21	24	27	30	33	36	39	40	41	41.3	42	44′		
	0.20	0.82	1.84	3.27	5.11	7.36	10.02	13.09	16.57	20.45	24.75	29.45	34.57	36.36	38.21	38.77	40.09	44″		
0	3	6	9	12	15	18	21	24	27	30	33	36	39	41	42	42.3	43	45′		
	0.20	0.80	1.80	3.20	5.00	7.20	9.80	12.80	16.20	20.00	24.20	28.80	33.80	37.36	39.20	39.76	41.09	45″		
0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	43	43.3	44	46′		
	0.20	0.78	1.76	3.13	4.89	7.04	9.59	12.52	15.85	19.57	23.68	28.17	33.06	38.35	40.20	40.76	42.09	46″		
0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	43	44	44.3	45	47′	
	0.19	0.77	1.72	3.06	4.79	6.89	9.38	12.26	15.51	19.15	23.17	27.57	32.36	37.53	39.34	41.19	41.76	43.09	47″	
0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	44	45	45.3	46	48′	
	0.19	0.75	1.69	3.00	4.69	6.75	9.19	12.00	15.19	18.75	22.68	27.00	31.69	36.75	40.33	42.18	42.75	44.08	48″	
0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	46	46.3	47	49′	
	0.18	0.73	1.65	2.94	4.59	6.61	9.00	11.76	14.88	18.37	22.22	26.45	31.04	36.00	41.33	43.18	43.75	45.08	49″	
0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	46	47	47.3	48	50′
	0.18	0.72	1.62	2.88	4.50	6.48	8.82	11.52	14.58	18.00	21.78	25.92	30.42	35.28	40.50	42.32	44.18	44.75	46.08	50″

Parabolic Curve with Tangent:—Total drop @ .027 ft. per foot. For use with smooth pavements, such as asphalt or brick.

The total drop from the vertex to the gutter line is taken @ .027 ft. × half the width of the roadway. For roadways having a half-width of 13 ft. to 50 ft., inclusive, a straight slope is assumed of .03 ft. in the first three feet from the vertex or center line towards the edge of the pavement, and this straight slope is a tangent from which a parabolic curve is constructed connecting the end of said tangent with the gutter. For roadways having a half-width of 5 ft. to 12 ft., inclusive, this tangent is taken as 2 ft. long with a drop of .02 ft. in its length.

In the table the ordinates 2 ft. from the gutter line are for use where a 2 ft. vitrified brick gutter is laid in connection with an asphalt pavement.

The ordinates 2.7 ft. from the gutter line are for use in setting catch basins whose gutter stones extend 2.7 ft. into the pavement.

The table was computed for typical normal conditions, but may be useful for comparison in other cases.

Parabolic Curve with Tangent:—Total Drop = .027 ft. per Foot.

0	2	2.3	3	5 '			
	1/4	5/16	1/2	1 5/8 "			
0	2	3.3	4	6 '			
	1/4	1/2	13/16	1 15/16 "			
0	2	4	4.3	5	7 '		
	1/4	11/16	13/16	1 1/8	2 1/4 "		
0	2	4	5.3	6	8 '		
	1/4	5/8	1 1/8	1 7/16	2 5/8 "		
0	2	4	6.3	7	9 '		
	1/4	5/8	1 7/16	1 3/4	2 15/16 "		
0	2	4	6	7.3	8	10 '	
	1/4	5/8	1 1/4	1 3/4	2 1/8	3 1/4 "	
0	2	4	6	8.3	9	11 '	
	1/4	9/16	1 3/16	2 1/8	2 7/16	3 9/16 "	
0	2	4	6	8	9.3	10	12 '
	1/4	9/16	1 1/8	1 7/8	2 7/16	2 3/4	3 7/8 "
0	3	6	9	10.3	11	13 '	
	3/8	1	2 1/16	2 5/8	3 1/16	4 3/16 "	
0	3	6	9	11.3	12	14 '	
	3/8	15/16	1 15/16	3	3 3/8	4 9/16 "	
0	3	6	9	12	12.3	13	15 '
	3/8	7/8	1 7/8	3 3/16	3 5/16	3 11/16	4 7/8 "
0	3	6	9	12	13.3	14	16 '
	3/8	7/8	1 3/4	3	3 11/16	4	5 3/16 "

0	3	6	9	12	14.3	15	17 '			
	3/8	7/8	1 11/16	2 7/8	4	4 3/8	5 1/2 "			
0	3	6	9	12	15	15.3	16	18 '		
	3/8	7/8	1 11/16	2 3/4	4 3/16	4 5/16	4 11/16	5 13/16 "		
0	3	6	9	12	15	16.3	17	19 '		
	3/8	7/8	1 5/8	2 5/8	4	4 5/8	5	5 1/8 "		
0	3	6	9	12	15	17.3	18	20 '		
	3/8	7/8	1 9/16	2 9/16	3 13/16	4 15/16	5 5/16	6 1/2 "		
0	3	6	9	12	15	18	18.3	19	21 '	
	3/8	13/16	1 9/16	2 1/2	3 11/16	5 1/8	5 5/16	5 11/16	6 13/16 "	
0	3	6	9	12	15	18	19.3	20	22 '	
	3/8	13/16	1 1/2	2 7/16	3 9/16	4 15/16	5 5/8	6	7 1/8 "	
0	3	6	9	12	15	18	20.3	21	23 '	
	3/8	13/16	1 1/2	2 3/8	3 1/2	4 13/16	5 15/16	6 5/16	7 7/16 "	
0	3	6	9	12	15	18	21	21.3	22	24 '
	3/8	13/16	1 1/2	2 5/16	3 7/16	4 11/16	6 1/8	6 5/16	6 11/16	7 3/4 "
0	3	6	9	12	15	18	21	22.3	23	25 '
	3/8	13/16	1 7/16	2 5/16	3 5/16	4 9/16	5 15/16	6 5/8	7	8 1/8 "
0	3	6	9	12	15	18	21	23 3	24	26 '
	3/8	13/16	1 7/16	2 1/4	3 1/4	4 7/16	5 3/4	6 15/16	7 5/16	8 7/16 "
0	3	6	9	12	15	18	21	24	24.3	25	27 '
	3/8	13/16	1 7/16	2 1/4	3 3/16	4 5/16	5 5/8	7 1/8	7 1/4	7 5/8	8 3/4 "
0	3	6	9	12	15	18	21	24	25.3	26	28 '
	3/8	13/16	1 7/16	2 3/16	3 1/8	4 1/4	5 1/2	6 15/16	7 9/16	7 15/16	9 1/16 "

Parabolic Curve with Tangent:—Total Drop=.027 feet per Foot.

0	3 3/8	6 13/16	9 1 3/8	12 2 1/8	15 3 1/16	18 4 1/8	21 5 3/8	24 6 5/8	26.3 7 7/8	27 8 1/4	29′ 9 3/8″				
0	3 3/8	6 13/16	9 1 3/8	12 2 1/8	15 3	18 4 1/16	21 5 1/4	24 6 9/16	27 8 1/16	27.3 8 1/4	28 8 5/8	30′ 9 3/4″			
0	3 3/8	6 13/16	9 1 3/8	12 2 1/8	15 2 15/16	18 4	21 5 1/8	24 6 7/16	27 7 7/8	28.3 8 9/16	29 8 15/16	31′ 10 1/16″			
0	3 3/8	6 13/16	9 1 3/8	12 2 1/16	15 2 15/16	18 3 15/16	21 5 1/16	24 6 5/16	27 7 11/16	29.3 8 7/8	30 9 1/4	32′ 10 3/8″			
0	3 3/8	6 13/16	9 1 5/16	12 2 1/16	15 2 7/8	18 3 7/8	21 4 15/16	24 6 3/16	27 7 1/2	30 9 1/16	30.3 9 3/16	31 9 9/16	33′ 10 11/16″		
0	3 3/8	6 3/4	9 1 5/16	12 2	15 2 13/16	18 3 13/16	21 4 7/8	24 6 1/16	27 7 3/8	30 8 7/8	31.3 9 9/16	32 9 15/16	34′ 11″		
0	3 3/8	6 3/4	9 1 5/16	12 2	15 2 13/16	18 3 3/4	21 4 3/4	24 5 15/16	27 7 1/4	30 8 11/16	32.3 9 7/8	33 10 1/4	35′ 11 5/16″		
0	3 3/8	6 3/4	9 1 5/16	12 2	15 2 3/4	18 3 11/16	21 4 11/16	24 5 7/8	27 7 1/8	30 8 9/16	33 10	33.3 10 3/16	34 10 9/16	36′ 11 11/16″	
0	3 3/8	6 3/4	9 1 5/16	12 2	15 2 3/4	18 3 5/8	21 4 5/8	24 5 3/4	27 7	30 8 3/8	33 9 13/16	34.3 10 1/2	35 10 7/8	37′ 12″	
0	3 3/8	6 3/4	9 1 5/16	12 1 15/16	15 2 11/16	18 3 9/16	21 4 9/16	24 5 11/16	27 6 7/8	30 8 3/16	33 9 5/8	35.3 10 13/16	36 11 3/16	38′ 12 5/16″	
0	3 3/8	6 3/4	9 1 5/16	12 1 15/16	15 2 11/16	18 3 1/2	21 4 1/2	24 5 5/8	27 6 3/4	30 8 1/16	33 9 7/16	36 11	36.3 11 3/16	37 11 1/2	39′ 12 5/8″
0	3 3/8	6 3/4	9 1 5/16	12 1 15/16	15 2 11/16	18 3 1/2	21 4 7/16	24 5 1/2	27 6 11/16	30 7 15/16	33 9 3/16	36 10 13/16	37.3 11 1/2	38 11 7/8	40′ 12 13/16″

Parabolic Curve with Tangent:—Total Drop = .027 ft. per Foot.

0	3 3/8	6 3/4	9 1 5/16	12 1 15/16	15 2 5/8	18 3 1/2	21 4 3/8	24 5 7/16	27 6 9/16	30 7 13/16	33 9 3/16	36 10 5/8	38.3 11 13/16	39 12 3/16	41 ′ 13 1/4″		
0	3 3/8	6 3/4	9 1 5/16	12 1 7/8	15 2 5/8	18 3 7/16	21 4 3/8	24 5 3/8	27 6 1/2	30 7 11/16	33 9 1/16	36 10 7/16	39 12	39.3 12 1/8	40 12 1/2	42 ′ 13 5/8″	
0	3 3/8	6 3/4	9 1 5/16	12 1 7/8	15 2 5/8	18 3 3/8	21 4 5/16	24 5 5/16	27 6 7/16	30 7 5/8	33 8 15/16	36 10 5/16	39 11 13/16	40.3 12 7/16	41 12 13/16	43 ′ 13 15/16″	
0	3 3/8	6 3/4	9 1 1/4	12 1 7/8	15 2 9/16	18 3 3/8	21 4 1/4	24 5 1/4	27 6 5/16	30 7 1/2	33 8 3/4	36 10 1/8	39 11 5/8	41.3 12 13/16	42 13 3/16	44 ′ 14 1/4″	
0	3 3/8	6 3/4	9 1 1/4	12 1 7/8	15 2 9/16	18 3 5/16	21 4 3/16	24 5 3/16	27 6 1/4	30 7 3/8	33 8 5/8	36 10	39 11 7/16	42 12 15/16	42.3 13 1/8	43 13 1/2	45 ′ 14 9/16″
0	3 3/8	6 3/4	9 1 1/4	12 1 7/8	15 2 9/16	18 3 5/16	21 4 3/16	24 5 1/8	27 6 3/16	30 7 5/16	33 8 1/2	36 9 7/8	39 11 5/16	42 12 3/4	43.3 13 7/16	44 13 13/16	46 ′ 14 7/8″
0	3 3/8	6 3/4	9 1 1/4	12 1 7/8	15 2 1/2	18 3 1/4	21 4 1/8	24 5 1/16	27 6 1/8	30 7 1/4	33 8 7/16	36 9 3/4	39 11 1/8	42 12 9/16	44.3 13 3/4	45 14 1/8	47 ′ 15 1/4″
0	3 3/8	6 3/4	9 1 1/4	12 1 13/16	15 2 1/2	18 3 1/4	21 4 1/16	24 5	27 6	30 7 1/8	33 8 5/16	36 9 5/8	39 10 15/16	42 12 7/16	45 13 15/16	45.3 14 1/16	46 14 1/2	48 ′ 15 9/16″
0	3 3/8	6 3/4	9 1 1/4	12 1 13/16	15 2 1/2	18 3 3/16	21 4	24 4 15/16	27 5 15/16	30 7 1/16	33 8 1/4	36 9 7/16	39 10 13/16	42 12 1/4	45 13 3/4	46.3 14 3/8	47 14 13/16	49 ′ 15 7/8″
0	3 3/8	6 3/4	9 1 1/4	12 1 13/16	15 2 1/2	18 3 3/16	21 4	24 4 7/8	27 5 7/8	30 7	33 8 1/8	36 9 5/16	39 10 11/16	42 12 1/16	45 13 9/16	47.3 14 11/16	48 15 1/8	50 ′ 16 3/16″

The table of curves for crushed stone pavements is on the same general plan as the table for smooth pavements.

For half-widths of 5 feet to 9 feet inclusive, the drop from vertex to gutter line is taken as half the width of the roadway in feet × ½ inch, + 1 inch.

For half-widths of 10 feet to 15 feet inclusive, use half width of roadway in feet × ½ inch, + ½ inch.

For half-widths of 16 feet to 50 feet inclusive, use half width of roadway in feet × ½ inch.

The curves of 5 feet to 15 feet, half width, vary in the length and pitch of the tangent forming the vertex.

Curves of 16 feet to 50 feet, half width, have tangent 4 feet long with a pitch of ¾ inch in its length.

A few of the shorter curves are arbitrary, but are believed to be practicable.

A break in the regular sequence of the table is indicated by a horizontal line.

Where a gutter of cobbles, Belgian blocks, brick, etc., is laid in connection with a crushed stone pavement, it is customary to drop the edges of such gutter ½ inch below the elevations of the corresponding points in the curve as given in the table.

This table includes special ordinates at 2.7 feet, 3 feet and 4 feet from the gutter line.

PARABOLIC CURVE WITH TANGENT:—FOR CRUSHED STONE PAVEMENTS.

0	2.3 1	3 1½	5′ 3½″			
0	2 ¾	3.3 1½	4 2	6′ 4″		
0	2 ¾	4.3 2	5 2½	7′ 4½″		
0	2 ⅝	4 1½	5 2⅛	5.3 2⅜	6 3	8′ 5″
0	3 ⅞	5 1¾	6 2½	6.3 2¾	9′ 5½″	
0	3 ¾	6 2	7 2¾	7.3 3	10′ 5½″	
0	3 ¾	6 2	7 2⅝	8 3¼	8.3 3½	11′ 6″
0	3 ⅝	6 1¾	8 2⅞	9 3⅝	9.3 3⅞	12′ 6½″
0	3 ⅝	6 1⅝	9 3⅜	10 4⅛	10.3 4⅜	13′ 7″
0	4 ¾	8 2¼	10 3⅝	11 4½	11.3 4¾	14′ 7½″
0	4 ¾	8 2⅛	11 4⅛	12 5	12.3 5¼	15′ 8″
0	4 ¾	8 2⅛	12 4½	13 5¼	13.3 5½	16′ 8″

0	4 ¾	8 2	12 4¼	13 5	14 5¾	14.3 6	17′ 8½″		
0	4 ¾	8 2	12 4⅛	14 5½	15 6¼	15.3 6½	18′ 9″		
0	4 ¾	8 1⅞	12 4	15 6	16 6¾	16.3 7	19′ 9½″		
0	4 ¾	8 1⅞	12 3¾	16 6½	17 7¼	17.3 7½	20′ 10″		
0	4 ¾	8 1⅞	12 3¾	16 6¼	17 7	18 7⅞	18.3 8⅛	21′ 10½″	
0	4 ¾	8 1⅞	12 3⅝	16 6	18 7½	19 8⅜	19.3 8⅝	22′ 11″	
0	4 ¾	8 1⅞	12 3½	16 5⅞	19 8	20 8⅞	20.3 9⅛	23′ 11½″	
0	4 ¾	8 1¾	12 3½	16 5¾	20 8½	21 9⅜	21.3 9⅝	24′ 12″	
0	4 ¾	8 1¾	12 3⅜	16 5½	20 8¼	21 9	22 9⅞	22.3 10⅛	25′ 12½″
0	4 ¾	8 1¾	12 3⅜	16 5⅜	20 8	22 9⅝	23 10⅜	23.3 10⅝	26′ 13″
0	4 ¾	8 1¾	12 3¼	16 5¼	20 7⅞	23 10⅛	24 10⅞	24.3 11⅛	27′ 13½″
0	4 ¾	8 1¾	12 3¼	16 5⅛	20 7⅝	24 10⅝	25 11⅜	25.3 11⅝	28′ 14″

PARABOLIC CURVE WITH TANGENT:—FOR CRUSHED STONE PAVEMENTS.

0	4 ¾	8 1¾	12 3⅛	16 5⅛	20 7⅛	24 10⅜	25 11⅛	26 11⅞	26.3 12⅛	29′ 14½″		
0	4 ¾	8 1¾	12 3⅛	16 5	20 7¼	24 10	26 11⅝	27 12⅜	27.3 12⅝	30′ 15″		
0	4 ¾	8 1¾	12 3⅛	16 4⅞	20 7⅛	24 9¾	27 12⅛	28 12⅞	28.3 13⅛	31′ 15½″		
0	4 ¾	8 1¾	12 3⅛	16 4⅞	20 7	24 9⅝	28 12⅝	29 13⅜	29.3 13⅝	32′ 16″		
0	4 ¾	8 1¾	12 3	16 4¾	20 6⅞	24 9⅜	28 12⅜	29 13⅛	30 13⅞	30.3 14⅛	33′ 16½″	
0	4 ¾	8 1¾	12 3	16 4¾	20 6¾	24 9¼	28 12⅛	30 13⅝	31 14⅜	31.3 14⅝	34′ 17″	
0	4 ¾	8 1⅝	12 3	16 4⅝	20 6⅝	24 9	28 11⅞	31 14	32 14⅞	32.3 15⅛	35′ 17½″	
0	4 ¾	8 1⅝	12 3	16 4⅝	20 6⅝	24 8⅞	28 11⅝	32 14⅝	33 15⅜	33.3 15⅝	36′ 18″	
0	4 ¾	8 1⅝	12 3	16 4½	20 6½	24 8¾	28 11⅜	32 14⅜	33 15⅛	34 15⅞	34.3 16⅛	37′ 18½″
0	4 ¾	8 1⅝	12 2⅞	16 4½	20 6⅜	24 8⅝	28 11⅛	32 14	34 15⅝	35 16⅜	35.3 16⅝	38′ 19″
0	4 ¾	8 1⅝	12 2⅞	16 4⅜	20 6¼	24 8½	28 11	32 13¾	35 16⅛	36 16⅞	36.3 17⅛	39′ 19½″
0	4 ¾	8 1⅝	12 2⅞	16 4⅜	20 6¼	24 8⅜	28 10⅞	32 13⅝	36 16⅝	37 17½	37.3 17¾	40′ 20″

PARABOLIC CURVE WITH TANGENT:—FOR CRUSHED STONE PAVEMENTS.

0	4	8	12	16	20	24	28	32	36	37	38	38.3	41′	
	¾	1⅝	2⅞	4⅜	6⅛	8½	10⅝	13⅜	16⅝	17⅛	18	18½	20½″	
0	4	8	12	16	20	24	28	32	36	38	39	39.3	42′	
	¾	1⅝	2⅞	4¼	6⅛	8⅛	10½	13⅛	16	17⅝	18½	18⅝	21″	
0	4	8	12	16	20	24	28	32	36	39	40	40.3	43′	
	¾	1⅝	2⅞	4¼	6	8	10⅜	12⅞	15¾	18⅛	19	19¼	21½″	
0	4	8	12	16	20	24	28	32	36	40	41	41.3	44′	
	¾	1⅝	2¾	4¼	6	7⅞	10¼	12⅝	15½	18⅝	19⅛	19⅝	22″	
0	4	8	12	16	20	24	28	32	36	40	41	42	42.3	45′
	¾	1⅝	2¾	4¼	5⅞	7⅞	10⅛	12½	15¼	18⅝	19⅛	19⅞	20⅛	22½″
0	4	8	12	16	20	24	28	32	36	40	42	43	43.3	46′
	¾	1⅝	2¾	4⅛	5⅞	7¾	10	12⅜	15⅛	18⅛	19⅝	20⅝	20⅝	23″
0	4	8	12	16	20	24	28	32	36	40	43	44	44.3	47′
	¾	1⅝	2¾	4⅛	5¾	7⅝	9⅞	12¼	14⅞	17⅞	20⅛	20⅞	21⅛	23½″
0	4	8	12	16	20	24	28	32	36	40	44	45	45.3	48′
	¾	1⅝	2¾	4⅛	5¾	7⅝	9¾	12⅛	14⅝	17½	20⅝	21⅝	21⅝	24″
0	4	8	12	16	20	24	28	32	36	40	44	45	46	46.3	49′
	¾	1⅝	2¾	4⅛	5⅝	7½	9⅝	11⅞	14½	17¼	20⅝	21⅛	21⅞	22⅛	24½″
0	4	8	12	16	20	24	28	32	36	40	44	46	47	47.3	50′
	¾	1⅝	2¾	4⅛	5⅝	7½	9½	11¾	14⅜	17⅛	20½	21⅝	22½	22¾	25″

THE PRESIDENT: The next report is the report of the Committee on Law.

MR. BUNCE: Mr. President, and gentlemen—I had sent out a circular containing a series of replies to questions which it seemed to me might make the commencement of an interesting lot of information for the Society; these were in regard to cases in court that had been settled on various points,—point of dispute that we might meet in our practice. I am sorry to say that I did not receive a single answer to those queries, and consequently the Committee on Law has no report to make.

THE PRESIDENT: The next committee is the Committee on Water Supply. Mr. William E. Johnson of Hartford, Chairman.

MR. JOHNSON: I have a report, Mr. Chairman, which I will present to the Secretary during the day.

COMMITTEE ON WATER SUPPLY.

In answer to the circular letter of inquiry sent out by the Connecticut Society of Civil Engineers the Water Supply Committee have received but ten answers to the questions inclosed.

NEW LONDON.

The water department have increased their storage capacity by the construction of a new reservoir (about 175 million gallons) and connections, cost to date $175,000.

There have been set 270 meters, makes and sizes not stated.

Precipitation January 1 to December 31, 1902, 51.98 inches.

W. H. RICHARDS, *Engineer.*

NORWICH.

The Board of Water Commissioners have increased their storage capacity 80 million gallons by enlarging existing reservoir, cost to be about $50,000.

Precipitation January 1 to December 31, 1902, 41.54 inches, exclusive of 35 inches of snow in January, February and March.

C. E. CHANDLER and S. B. PALMER, *Engineers.*

MERIDEN.

There has been no increase in the storage capacity during the year.

Pumped water from May 11 to September 6, about 171 million gallons, cost $2,318.55.

No more than two or three meters placed during the year.

Precipitation January 1 to December 31, 1902, 48.68 inches.

Expect to lay about 3,900 feet of 16-inch water main, estimated cost $13,000, also to complete overflow wasteway at reservoir, estimated cost $5,000.

W. S. CLARK, *City Engineer.*

NORWALK.

Other than laying 3,000 feet of distributing mains nothing has been done.

Precipitation January 1 to December 31, 1902, 53.37 inches (local observer).

PRECIPITATION, NORWALK, CONN., BY MONTHS.

1902.

January	2.57 in.	May	2.60 in.	September	7.87 in.
February	4.62 "	June	4.72 "	October	7.64 "
March	5.71 "	July	2.45 "	November	1.30 "
April	3.78 "	August	3.09 "	December	7.02 "

Total.................... 53.37 inches.

C. N. WOOD, *Engineer.*

PRECIPITATION AT WATERBURY, CONN.

1902.

January	3.43 in.	May	2.01 in.	September	6.42 in.
February	6.67 "	June	5.16 "	October	6.19 "
March	5.56 "	July	4.58 "	November	1.34 "
April	4.11 "	August	2.82 "	December	6.92 "

Total.................... 55.21 inches.

NELSON J. WELTON, *Civil Engineer.*

MIDDLETOWN.

Number of meters set during the year was 77, size and make not given.

Precipitation January 1 to December 31, 1902, 54.18 inches. There have been laid 1,630 feet of 12-inch pipe and 3,348 feet of 8-inch pipe.

NORFOLK (The Norfolk Water Co.).

Laid about 3,000 feet of 6-inch cast iron pipe.

EDWARD BROWN, *Engineer.*

BRIDGEPORT (Bridgeport Hydraulic Co.).

Number of meters set during the year 203, the following makes being used, Crown, Hersey, Irene, Thompson, Union. The water supplied is of excellent quality and amounts to about 300 gallons per capita in twenty-four hours.

SAM'L SENIOR, *Superintendent and Engineer.*

HARTFORD.

MR. GALLUP, *Dear Sir:*—Your questions don't seem to me to cover all the ground by any means. However, for my part will say, that I have plans made and approved for several water works systems. Have been on three flowage cases, in one of which we got large damages, in the others small ones. In one now pending, Hazard Powder Co. and Somersville Mfg. Co., both sides are making a strong fight regardless of expense and it will be a case of considerable interest.

Have also made maps for other court cases where claims were made for damages, and done some work in connection with water used for power.

Yours very truly,
(Signed) H. W. AYRES.

W. E. JOHNSON, *Chairman.*

THE PRESIDENT: The report of these committees, of course it is understood, will be printed in the Proceedings.

The next business before the meeting is the election of new members. I believe there are some twelve or fourteen to be passed upon, and two to transfer from the active to the honorary list.

THE SECRETARY: Mr. Edgar Clark of Putnam, Conn., and Mr. Bradley H. Hull of Bridgeport, both of whom are now active members of the Society, are recommended by the Board of Direction for election as honorary members.

THE PRESIDENT: The election of these members requires the unanimous vote of every person, so you will prepare your ballots for Mr. Bradley H. Hull and Mr. Edgar Clark as honorary members. Mr. Snell and Mr. Spencer will please act as tellers for the canvass of this vote.

On motion by Mr. LaForge, it was voted that the Secretary cast one ballot for Mr. Hull. Mr. Hull was declared duly elected an honorary member by the President.

On motion by Mr. Kellogg, the Secretary was instructed to cast one ballot for Mr. Clark. Mr. Clark was declared duly elected an honorary member by the President.

THE SECRETARY: We have the following applications for membership from: Frederick S. Chapman, New London; William R. C. Corson, Hartford; Aubrey D. Fuller, New Haven; Percy T. W. Hale, Portland; F. B. Hastings as an associate member, Bridgeport; Adrian C. Heitman, Jr., West Haven; Frank B. Jaynes, Bridgeport; Walter A. Jones, New Haven; Edwin M. Lee, New Haven; Robert Q. MacMahon, New London; Major Charles F. Powell, New London; George E. Smith, Derby; Joseph P. Wadhams, Torrington; and Frederick S. Wardell of Stamford.

These names have been regularly printed upon the call for the meeting, have been approved by the Board of Direction, and I therefore move, Mr. President, that they be admitted to membership in the Society.

MR. GRAVES: I will second that motion, Mr. Chairman, with great pleasure.

Motion carried and the gentlemen whose names were read were declared duly elected by the President.

THE PRESIDENT: The next order of business is the election of officers. The polls, however, will not close until eleven o'clock, and as it is only ten minutes of eleven, with the consent of the members I will deliver the address of the President at this time.

ADDRESS OF PRESIDENT C. B. VORCE.

After several meetings of the Board of Direction and a careful consideration of the subject, it was thought best, this year at least, to omit the usual spring meeting of the Society, and to have but one meeting. It was also decided to hold this meeting in the fall rather than in the summer, as at that time it was hoped a fuller attendance could be secured.

The successful meeting held at New London in 1901, both in point of attendance and the exceptional interest of the work examined, has set such a high standard for the Society, that the Board of Direction was rather at sea where to hold the fall meeting. A postal was sent to each member to get an expression, if possible, where the Society would like to go. It was then decided to hold the meeting in Bridgeport, as that place seemed to present more engineering features than any other in this State, and October 11th was fixed upon as the date.

At ten o'clock Saturday, October 11th, the members of the Society met at the Atlantic Hotel in Bridgeport, and transacted routine business, admitting several new members, and then adjourned to examine the new work being done by the Consolidated Railroad, under the guidance of the engineers of that company. The work consists of raising the grade of the tracks through the city, eliminating thereby about twenty-five grade crossings, changing the line and grade, building two additional tracks (making four main tracks to be laid with one hundred pound steel), and building a new station. The total cost of this work is to be about $4,000,000.

The work is divided into three parts. The west Bridgeport, middle, and east Bridgeport sections. At the west and east Bridgeport sections the tracks are raised some fifteen feet by masonry retaining walls, and the streets are spanned by steel bridges. The middle section, along the water front of the Pequonock River, is about three thousand two hundred feet long, and consists of a steel plate girder viaduct, carried on masonry piers, every fourth pier coming up to the under side of the girder. At the point where the line crosses the Pequonock River, about two hundred feet south of the present bridge, all the piers are carried up to the level of the under side of the girder, and the river is spanned by a Scherzer Rolling Lift

Bridge. The caisson for the pier of the lift bridge is one of the largest open box caissons ever constructed. It consists of a grillage of four layers of 12″ x 12″ Southern pine. The first course is laid transversely, the second and third diagonally, and the fourth or top course longitudinally. This grillage is drift-bolted with ⅞″ x 18″ square drift-bolts. The grillage was then floated and the framed sides of the caisson were attached by rods hung from the top-plates and hooking into eye-bolts in the grillage, to permit easy detachment. Sufficient interior bracing was provided and the caissons were sheeted with 3″ or 4″ plank, tightly caulked with oakum.

After viewing the work of the Consolidated Railroad, the Society examined the vitrified brick pavement being laid on Seaview avenue, and the Yellow Mill Pond drawbridge. Unfortunately at this time the clouds, which had looked rather watery, concluded to give us some of their contents and the examination of a very interesting Open Hearth steel plant of the American Tube & Stamping Co. was necessarily somewhat shortened. In spite of the rain, however, Mr. Leutscher and Mr. Sterling, the superintendent and engineer of the company, kindly showed the members of the Society the work which was then in progress and explained to them what was contemplated.

The plant consists of three 35-ton basic open-hearth furnaces and a 34″ blooming mill. The main building is entirely of iron, 608′ x 110′, built on three rows of concrete piers. The pier footings are designed for a load of three thousand pounds to a square foot, and the piers proper for a load of five thousand pounds to the square foot. The load on the center columns is 256,000 pounds. The piers, with the exception of those next to the furnaces, are of Portland cement concrete. In the footings the mixture is 1–3–6 and in the piers 1–3–5. The mixing was all done by hand and about six thousand yards were used. The forms were adjustable and were built of 1¼″ stuff, tongued and grooved, and planed on one side. After twenty-four hours the forms were removed and were used again. The concrete was not set so hard at this time but that the face could be troweled over and a smooth finish given to the piers. The bolts in the piers were set in a 6″ piece of tin pipe, enabling the position of the bolt to be adjusted to fit the column. When the building was lined up these pipes were filled with grout. The foundations of the mill, engines and tables contained about 2,500 yards of concrete. The engine and mill foundation were about 18′ deep and a wall 5′ deeper was built all around the outside to prevent any possibility of settlement. In addition to the main building there is a gas-producer house 190′ x 30′, with concrete walls 15′ high, the superstructure and roof being iron. A boiler house 125′ x 50′ with ten two hundred and thirty horse power boilers. A machine shop and dynamo house 90′ x 50′. There is also an electric railroad about a mile long, connecting the shop yard with the N. Y., N. H. & H. R. R. freight yard, enabling receipts and shipments to be made in carload lots. About two miles of narrow gauge tracks have been built for moving both the unfinished and finished product around the mill and to the stock yard. This narrow gauge road is operated by a Porter locomotive. The plant is of the most modern construction and it is hoped that it will be ready to operate the early part of the coming summer.

After viewing all this interesting work the inner man commenced to assert himself, and the members journeyed to Otto Lehmann's, where the Chairman of the Committee on Arrangements had planned a most enjoyable menu for us. Mr. Lehmann had certainly "done himself proud," and the dinner which followed, interspersed by a good deal of "jollying" between the members, ended a very enjoyable day which all present will long remember.

The Connecticut Society of Civil Engineers has just passed its nineteenth birthday and is about to enter upon its twentieth year. It rests with the members themselves to say whether the coming year is going to broaden and enlarge the field of the Society's work. I want to call attention particularly to the fact that the greatest good to its members can only be reached by the hearty coöperation of all.

We are a company organized to advance the engineering profession in this State. We are all share-holders and elect each year officers to manage the affairs of the Society. But with this election our work is not done. We want to let nothing, except it is of very great importance, prevent us from attending the meetings of the Society. The date of the annual meeting is fixed by the Constitution, and we know that is the second Tuesday of February. A large number of the members are seen at every meeting of the Society, and by their efforts the Society has grown from a small beginning, nearly twenty years ago, to a membership now of over two hundred, and to a place among the foremost of the State Engineering Societies. However glad we may be to see the old familiar faces each year, we want also to see among them the faces of those members with whom we are not familiar. The only way to become intimately acquainted is for us all to make a special effort and to try and let nothing prevent us from attending the Society's meetings.

Notwithstanding the growth of the Society during the past few years, we are pursuing the same method of holding our annual meetings as when the membership was much smaller. We have now but one day's session, the morning being taken up by the business meeting, which I do not think can be shortened, and the afternoon is taken up by the dinner and a few papers for which we have time before the departure of the evening trains. Most other societies of our size and standing have a two or three days' session. The area in which their members live is, I know, much larger than the area covered by the membership of this Society. With our membership I think we could make a two-day session both interesting and instructive. The papers, that are read at our meeting, we have very little time to discuss, and it is by this discussion that the ideas of our members are brought out and many points are made clear. One member has, in some of his work, observed facts or gathered data which is new and by exchanging these ideas we are all learning and getting the greatest good from the Society. I would like to see this discussion of the papers made the most prominent features in our meetings and the only way to do this is to have our meetings last longer than one day. I would suggest a plan for our annual meeting something as follows: Try for one year a two days' session. The first morning would be taken up with the business meeting. The reports of the committees can be taken up and discussed during the afternoon, a feature which we do not have time to do now. The evening can be devoted to the annual dinner, after which we can have a social gathering, when the members can meet each other and talk over informally subjects of mutual interest. The next day to be devoted to papers and discussions of same. The topics of these papers to be given out far enough in advance of the annual meeting so that the members will have time to look over the subjects and, if they cannot be present, they can send a written discussion to the Society which can either be read or printed in the proceedings.

At the meeting to-day the subject of concrete will be presented to the Society by one of our members, and the subject is surely one of interest to all. The use of concrete has increased with such rapid strides during the past two years that nearly every engineering structure uses it in some portion of the work.

At the conclusion of the paper I hope many of the members will take the opportunity given for discussion, and even if the time is short we can at least make a start in this, the right direction. When the Society gets a taste of this I hope the doses will be of the old allopathic kind, and I trust that the lack of time will so appeal to the members that they will see the necessity of having more time at our annual meeting.

In accordance with the custom of past years I have sent out to each member, with a stamped return envelope, a list of questions to aid the different committees in making up their reports. While these questions may not have covered the ground fully, any member, having data covering work not included in these questions, could have written a letter embodying it, and this several members did. The Society is always glad to hear from its members. To these questions only about ten per cent. of the members have replied. It seems to me that more than this number have been connected with work that would be of interest to the Society. I am sure that the small percentage of replies has been caused entirely by the modesty of the members. Their work may have seemed simple to them, and possibly it has only been the same routine work which is done each year; however, it is the faculty of applying the knowledge thus obtained that makes our large and important engineering work possible. It is also by gathering and tabulating and applying these seemingly simple methods that our profession has attained the position it occupies to-day.

In our 1902 annual the Committee on Sewerage published data that has never before been compiled. This work required a great amount of time, but it was freely given by the members of the committee to advance the position of the Society of which

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you, as well as they, are members. And advancing we certainly are. Our membership has increased during the past three years nearly thirty per cent. The size of our publication has also increased nearly three hundred per cent. Our advertisers are realizing the importance of our publication. The edition of the annual report has become too small and hereafter our thousand copies will not be enough. This year our Secretary was unable to fill a number of requests for our publication. Among them was one from Honolulu and one from South Australia.

Simply because our Society is prosperous we do not want to rest on our laurels. The appropriation for the macadam road, on which we are now riding so smoothly, is only for a given length: beyond there are hills to climb and portions requiring a large amount of grading. Let us see that this road is extended year by year, so that we shall never reach the end. Let each member take a certain portion of this work as his own, and let our watchword be "The Connecticut Society of Civil Engineers," may her usefulness to us and our usefulness to her ever grow greater. (Applause.)

It is eleven o'clock and I therefore declare the ballots for officers closed. I would say that it has been found that the count of the ballots will take a good deal of time. The tellers tell me it will probably take twenty or thirty minutes longer to count the ballots, and if the Society would like we can proceed with the ninth order of business while we are waiting for the report. If there is any miscellaneous business to come before the Society, now would be the proper time to bring it forward.

MR. CADWELL: Mr. Chairman, I would like to extend to the Society for its consideration, an invitation to come to New Britain and view the sewer work there some time in July, August or September.

THE PRESIDENT: I am sure that the incoming Board of Direction will be glad to give that place very great consideration.

MR. KELLOGG: Mr. President, I would like to call the attention of the meeting to an amendment to the Constitution that has been presented to the Secretary.

The President: Will the Secretary please read this amendment to the Constitution that has been offered.

The Secretary: I have the following amendment to the Constitution, which has been signed as required by three members of the Society, and which is as follows: it's an amendment to Section 7, Article IV of the Constitution.

"Add thereto, 'By a unanimous vote of the meeting a ballot for a candidate or candidates for membership may be cast by the Secretary.' "

Mr. Kellogg: Mr. President, the reason for presenting this may perhaps seem useless, but on a close reading of the section I think it is a little ambiguous. When I was the presiding officer last year, I said that if it was the sense of the meeting the rule as it reads there would be suspended. I was taken to task quite a little upon it by a reporter, who had attended and written up conventions a good many times. He said that you could suspend a by-law, but that he did not know of any precedent by which it was correct practice to suspend a section of the Constitution. I believe, in accordance with Roberts' rules, which we are under now, that he was probably correct. To-day we have done the same thing, having had a precedent for doing so in every meeting that we have ever held. Some question may arise about it, and therefore I offer this amendment.

Mr. Bunce: I should like to have the section read that is referred to.

The President: It's Section 7 of Article IV. The section now reads, as I have it, that each application shall be announced upon the notice of the next meeting; can then be considered by the Board of Direction, and if approved, shall be presented to the Society for a ballot at the regular meeting. The candidate receiving a majority of votes shall be declared elected.

Mr. Bunce: The only objection, Mr. President, as it strikes me, to this matter is if that section of the new Constitution is changed, it is a change from our original practice. Our original practice, I think, was that one vote was sufficient to kill the membership. Now it's a majority vote. If you adopt this proposed suggestion you have made your boundaries very much narrower in that instead of a majority vote, it will be necessary for a unanimous vote. It had not struck me when I signed that amendment to the Constitution, at Mr. Kellogg's request, just what the effect would be. I think it's worth considering.

MR. KELLOGG: Mr. President, Mr. Bunce may be right. I think, however, that the wording is safe, as it simply says that it may be so. It doesn't say it shall be so and it doesn't make it absolutely binding, or any different from a majority vote than it was before. And further, it only states that the ballots may be cast by the Secretary. The meeting can vote just the same as now, or it can vote under this to let the Secretary cast the ballot if the members wish to have it that way.

THE PRESIDENT: That is the way I understood it. It simply gives a little more leeway, so that by a unanimous vote of the meeting the ballot for a member may be cast by the Secretary.

MR. KELLOGG: The unanimous part, Mr. Chairman, is only meant to refer to that particular vote in case they wish to do it that way.

THE PRESIDENT: Is there any further discussion?

MR. BUNCE: If a majority vote elects a man, why is it not proper that a majority vote should instruct the Secretary to cast the ballot? Why is it necessary to have that a unanimous vote? If the majority vote of the Society now constitutes a confirmation of a candidate, why should it be necessary to have the unanimous vote in order for the Secretary to cast that ballot? Why shouldn't it be a majority vote in one case just as much as in the other?

MR. KELLOGG: I would say that the reason for putting unanimous vote in there was because by giving the Secretary power to cast that vote for a candidate we would thereby abridge somewhat the privileges of a member of the Society, and in order to protect that privilege of a member of the Society I thought it might be better to make it a unanimous vote to do so. That was the only idea there.

A MEMBER: As I understand this amendment of Mr. Kellogg's, it is to authorize the Secretary to cast the ballot of the Society so as to save the Society the trouble and time involved in casting individual ballots. If I am right about my understanding of the matter it seems to me that that is not at all necessary. In any parliamentary organization where the rules call for a ballot, it is always legal and permissible for the Secretary to cast the ballot for the Society, and it is an election by ballot if that is done. If the Secretary is authorized by a vote, by any kind of a vote of the Society, if the Secretary is so authorized to cast the ballot of the Society for a candidate, my impression is that is always regarded as the equivalent of a vote by ballot of the members of the Society themselves. I think I am right about that; and if that is so, then of course it would follow that this was not necessary.

THE PRESIDENT: It will be well to look some of these points up. Of course we do not act on it now. Is there any more discussion on this question of an amendment to the Constitution?

MR. BUNCE: As the Chair suggests, I suppose there is no vote necessary, as it goes to the next meeting, and that will give the members an opportunity to think the matter over and make up their minds whether they will vote for or against it at that time.

THE PRESIDENT: Is there any more new business?

MR. BUNCE: I have a matter I would like to bring before the Society. It has been suggested by a portion of your address, Mr. President, and it has come to me in various ways and from various sources, that there is more or less of a desire on the part of some members, and perhaps a good many members, that these annual meetings of ours should be made a two days' session rather than one. And in order that this matter may be brought before this Society for discussion, or for suggestions, I will move you, sir, that the annual meeting of the Society hereafter be extended over two days.

Motion seconded.

THE PRESIDENT: Gentlemen, the motion is made and seconded that the annual meetings of the Society be extended over two days. This is an important matter. It is quite a change from our usual custom and I should like to hear some discussion on this before it is put to a vote.

MR. PUNDERFORD: Mr. President, I do not believe the Society can make a very serious error in trying it for one year anyway. If we transact our regular business at the first meeting we shall accomplish all that we are doing now. If it was made a two days' meeting there would be opportunity, as I can see, for us to get a good deal more benefit out of these meetings. I am not quite sure how it would work, but I think it might be a good plan to try it one year anyway. Probably most of us would go home over night, and if upon the second day we should fail to have a quorum, which is thirty per cent., that being the requisite number, we have not lost very much excep our transportation for coming up on the second day. It seem to me though that a good many of our members will tak advantage of the privilege, and this will give us a chance t get better acquainted and to have more social sessions wit each other in the way of informal talks. Certainly, as we mee now, we have very little time to get much out of the session i the way of expressions of opinions from our various member upon many subjects which it would be advantageous if we coul have an opportunity to talk over. I know that there are certai points in our practical work upon which it would be very advantageous to the members if they could obtain advice from engineers from different localities. I, personally, have lots of questions I would like to ask of brother railroad men, and I thin it would be a source of valuable information to us. I cann see how we are going to run very much of a hazard in trying for one year. If we find that it is not a success it will be a easy matter to change back to the old plan. If we try it and w do not have a respectable number on the second day we wi have done our regular business and will not have lost ver much. I should very much like to see it tried once anyway.

Mr. Graves: I would like to inquire if it is the intentio to have the dinner in the afternoon or in the evening of th first day? I should suppose, of course, it would be held i the evening. I thought that was one of the points in favor a two days' meeting; that it would give us time to have th dinner at night, with some sort of an evening entertainmen If, as Mr. Punderford says, we are going home, it would spo that feature. If we could have in the evening a sufficient numbe who would stay, and have some address, or some sort of stereopticon lecture on a subject in which we were intereste it would, of course, be a very pleasant and profitable evenin As the meeting is conducted now we do not have time t eat, much less to digest a dinner, and then listen to pape before it is time to go home. We are not able as the mee ings are now conducted to give some of the papers that a read before us the attention in the way of discussion that th subjects deserve. I am heartily in favor of trying a two day meeting, but I was wondering whether it was the idea t have a day meeting, to have the dinner in the afternoon, an then go home to come back for a meeting the next day, or whether it was the idea that we should have an evening session. Of course an evening session means staying over night. I suppose that is a matter of detail, however, which will perhaps be worked out by whomsoever has the matter in charge. I think that an evening session, or a programme that included an evening session, would be one that would be the most attractive one of the whole meeting.

A MEMBER: I do not think, Mr. President, that any of the particulars were specified in the motion for a two days' meeting. As Mr. Graves says, that would be a matter of detail to be worked out. I heartily agree with Mr. Graves in that I think the time for dinner is evening rather than afternoon. After eating a big dinner, which is what we now do, we do not pay much attention to the papers, I am afraid. I think if we have dinner in the evening, and then afterward had a long paper, or a stereopticon exhibition, or something of that kind carried out, as Mr. Graves suggests, making it something more than merely a formal time, and giving an opportunity for the members to get together for social intercourse and talks with one another, thereby giving an opportunity to come in personal contact and become well acquainted, we should soon find that it would be one of the most valuable features of the meeting, and that after we had tried it once we would not want to go back to the old way. Of course that is a matter which would be worked out later. It is not necessary for us to discuss now the exact procedure for the evening, but I would be heartily in favor of having the dinner in the evening, and of having the whole of the afternoon to devote to business, or to papers and their discussion. Of course, we know that there is a large proportion of the members who live in Hartford, or in the immediate vicinity, and the people that come from other towns cannot get back that night, but the expense would not be very great and I think considering what they would get out of it they would soon feel that they were amply repaid.

MR. PUNDERFORD: I did not mean, Mr. President, in anything that I said to forestall an evening session, because I think that would be one of the most important features of our meeting. I think there would be a large number of us that come from outside who would stay even if we didn't get away until eleven or twelve o'clock. That is, if we were compelled to return home that night, and I have no doubt a good many would return the next day. I believe it would be found that the value of the meetings would be such that a good proportion of our members would feel that they could not afford to lose them.

Mr. Bunce: In making the motion I made it purposely in that way in order to draw out suggestions from every side. I suppose, of course, that if the Society should vote to hold a two days' meeting the arrangement of details would be left to the Board of Direction. I purposely made the motion broad and did not mean to cover any of these points.

The President: Is there any further discussion?

Mr. Augur: Mr. President, I am in favor of a two days' session. I think the opportunity for discussion, and for hearing more papers, which could then be placed upon the programme, would be much increased and it would be for the benefit of us all. We could have a larger number of papers than we have had in the past.

The President: I do not think there would be any trouble in holding the members for an evening session. I think there are more than four or five members who would not go home evenings. (Laughter.)

A Member: I should be in favor of a two days' session. I think the Society has not had the proper opportunity to discuss some of the very interesting reports of the committees, and this might afford us an opportunity to discuss the reports of the committees of the last year. Furthermore, if we could, perhaps, have the meeting held a month or six weeks later, so that these reports could be ready in time and so that the members could have them in their hands, that would be a valuable feature. If we could have them before we left home, so much the better. We could make it very valuable, as the things contained in the reports which we should care to discuss would then be fresh in our minds.

The President: Your idea is that the reports should be in a month before the meeting, and then printed and distributed, and then we could have them at the annual meeting.

A Member: Mr. President, I think we had our meeting put off from January to February in order to have time to make up the reports after the first of January. Whether there would be time to also print them before this February meeting I do not know. If there is time, why that would be all right.

THE PRESIDENT: It seems to me we could get them out by the 25th of January. If that could be done, that would give two weeks before the meeting.

MR. AUGUR: I think if we could have the reports printed a short time before the meeting, or long enough before so that the members could read them over and make up their minds what they wanted to talk about, that would be time enough. I think it would be a very much better plan than the one we are now working upon. Under the present arrangement a man does not get a chance to read them over until some time after the meeting.

THE PRESIDENT: I think that can be done very easily. I would suggest to have the reports of the committees come in the afternoon, and have their discussion at that time. Then the evening for the dinner and have our formal jollification. And then as to the papers I think the subjects should be printed, if not the papers themselves, so that the members could have two or three weeks or a month to look up the subjects, and if any member couldn't be present, quite a good many of them probably might want to discuss them by papers or communications to the Society about them. A great many of the discussions of the American Society are contained in letters sent to the Secretary. They give their members two or three weeks to look up the subjects, and they have some valuable discussions in consequence, both on the papers which are presented and on the reports on the papers that are presented.

If there is no more discussion I will put the motion.

MR. CRAWFORD: Wouldn't it be well, Mr. President, to have the committee's reports, say about the beginning of January, and then have the Secretary print the reports and have them ready for distribution so that the members could look them over and come to the meeting prepared to report and to discuss them?

THE PRESIDENT: That has been suggested. It has been suggested that the reports of the committees should be printed and sent to the members before the date of the annual meeting.

MR. CRAWFORD: I think that the reports of the committees could be printed on rough sheets, printed in an inexpensive way and sent out to the members. It would certainly add, I am sure, a valuable feature to our discussions.

THE PRESIDENT: It has been suggested that the reports of the committees be printed and sent to the members on rough sheets, roughly bound.

MR. CRANDALL: If I remember, Mr. President, one thing that was put forward as a reason for changing the date of the annual meeting from January to February, was on account of these various reports not being ready by the first of January, as the work in many departments was not closed until December 31st, and consequently the data was not obtainable. That was one of the strong reasons why the time was changed from January to February. If that is the case, and if it was put over for the sake of these reports, I do not see how the Secretary could get them and have them distributed within any such time as suggested, but I think that's a good idea.

A MEMBER: That is so. Some of these reports could not be obtained perhaps. I know with some of the commissions their reports are not ready until quite late. Take the case of the Highway Commissioner's report and the Railroad Commissioners'.

THE PRESIDENT: That is a point. Mr. Hoyt is present. Mr. Hoyt, when does the Commissioner print his annual report? When is it ready for distribution?

MR. HOYT: It is printed in February sometime.

THE PRESIDENT: Would it be printed in time for this meeting?

MR. HOYT: It ought to be generally, but this year it will not be printed until about the first of March.

THE PRESIDENT: Can the data from that report be obtained by the Society?

MR. HOYT: Yes, but I don't know whether the subject matter could be given out before it goes to the Governor. It doesn't go to him until about two weeks before it is printed.

MR. CRAWFORD: I think if we could have our annual meeting about the beginning of March then we would have no trouble on account of these papers and reports not being ready. I suppose what was referred to more particularly here was the reports of the committees appointed by the Society.

THE PRESIDENT: Mr. Snell, what time does the Railroad Commissioners' report come out?

MR. SNELL: About the 15th of January this year.

THE PRESIDENT: Is that about the average time?

MR. SNELL: I think so, usually.

THE PRESIDENT: Then, if we had the reports printed about the 25th of January, that would give us at least two weeks to look the reports over and get ready for the discussion of them. I think if they could be printed about that time that for the most part we would have all we wanted. Does anyone want to move that as an amendment to the motion before the house?

MR. TRACY: It seems to me, Mr. President, that the discussion on this subject now relates to a matter of detail which I think very properly rests with the Board of Direction and the President in arranging for this meeting. It is something which it does not seem to me the meeting itself would care to arrange now, and it should be left to them. The idea in general of a two days' meeting is a good measure, I think. It would accomplish this result, in my opinion. It would give the engineers of the State an opportunity to know each other better, and that I think, at the present time, is one of the main features, and one of the main reasons for the existence of this Society. I heartily approve of the motion which does that in effect, but the discussion as to details of the meeting, at this time, it seems to me that simply an exchange of ideas upon that does not really amount to anything. The arangement of programme can be and should be left to the Board of Direction and the President. If we start out to have a two days' meeting it will run two days anyway.

THE PRESIDENT: Is there anything more to be said on this matter?

MR. SNELL: I move as an amendment to the motion that the report of the standing committees of this Society be printed by the Secretary and distributed to the members before the annual meeting; leaving it to the Secretary to get them out as soon as he can, but some time before the anual meeting so that members may have a chance to look them over.

THE PRESIDENT: It is moved and seconded that the annual meeting continue over two days hereafter, and that the Secretary shall have the reports of the standing committees printed some time before that day and distributed to members. All those in favor will signify in the usual manner.

Motion passed.

THE PRESIDENT: I understand that the Secretary has some more business to present to the meeting.

THE SECRETARY: I have the following communication from Mr. J. R. Ockerson, Chief of the Department of Liberal Arts, World's Fair, St. Louis, which was presented to the Board of Direction recently, and by them referred to the nineteenth annual meeting of the Society for action.

ST. LOUIS, U. S. A., July 10, 1902.

DEAR SIR:—I take great pleasure in sending to your Society certain printed matter relating to our great International Exposition which is to open in this city May 1, 1904.

This Department is making special efforts to secure a large display of exhibits illustrating the work of the engineer, which will fully demonstrate the importance of the profession through the large share it bears in the world's progress toward the highest utilization of the forces and materials of nature for the benefit of mankind.

It would be particularly gratifying to have the work of your members generously displayed among the exhibits in the form of models, plans, photographs, relief maps, literature, etc.

Will you kindly consider the propriety of having your Society take such steps as may be deemed necessary and proper to make a creditable exhibit of the work of your members?

Trusting that I may be favored with your coöperation in the interests of the profession, and that this communication will receive an early reply, I have the honor to be,

Yours very truly,
J. A. OCKERSON,
Chief, Department of Liberal Arts,
Mem. Am. Soc. C. E.

MR. GEO. K. CRANDALL,
Sec'y Connecticut Civil Engineers
and Surveyors Ass'n, New London, Conn.

THE PRESIDENT: Gentlemen, you hear this letter. Will you take any action.

MR. PUNDERFORD: I move, Mr. President, that it be referred to the next Board of Direction with power.

Motion seconded.

THE PRESIDENT: It is moved and seconded that the communication from the Chief of the Department of Liberal Arts of the World's Fair and Louisiana Purchase Exposition Company be referred to the Board of Direction.

THE SECRETARY: I would like to say in this connection that this is probably a very good time to ascertain if there are any members who have any exhibits which they would wish to send to this World's Fair? It would be easier to get that information now than if we wait until there is a meeting of the Board of Direction. I know there are some members who have relief maps for instance, but whether they would be willing to send them is another question. A map of the Hartford bridge would be a very nice exhibit, and there may be other exhibits among our members which would be suitable to send, and I think the time to find this out is now when we have the men together. If there are any of our members who have anything of this kind that they would like to send, the officers of the Society would like to have them make it known.

MR. CADWELL: I would like to ask at what time an exhibit has to be delivered?

THE SECRETARY: The Fair is to be held in 1904.

MR. CADWELL: Well, do we have to have exhibits there by January 1st?

THE PRESIDENT: It probably opens some time in April or May. The exhibits probably have to be there by that time.

THE PRESIDENT: Gentlemen, it has been moved and seconded that the communication of the Louisiana Purchase Exposition Company be referred to the Board of Direction, with power to act. All in favor say "aye." It is a vote.

MR. TRACY: Mr. President, I have a matter of business that I would like to bring up because I think the discussion ought not to be influenced by this ballot, the report on which we are soon to have. You will remember that a year ago an amendment was offered by the Chairman of the Nominating Committee, which aimed to take the election of officers out of the hands of a few men, and to put it in the hands of the Society. As a member of that Nominating Committee, I was heartily in accord with that movement. It seems to me, however, after thinking it over, that that was really a jump from the frying-pan into the fire. It seems to me that under our plan a member is simply offered a choice within a very narrow limit. He must either find out who the leading candidates are, or else he must throw his ballot away, in which case you are just as badly off as you were before. That is, a few men in the Society are naming the candidates. In the second place, this method of election is almost sure, if not this year in succeeding years, to throw the election of officers into this meeting, a thing which I do not think any of us want. Now, just as an illustration of how this works, I would like to quote some figures from the report of the ballots cast last year: Mr. A had 56 ballots for a certain office, of the ballots which were sent in from the members of the Society for such office, Mr. B had 39 and Mr. C had 22, so that Mr. A lacked several of a majority. That threw the election into the meeting, and the result that Mr. B and not Mr. A was elected, with the total number of 27 votes (the votes cast in this meeting being 12 less than the number of votes cast for Mr. A on the first ballot), shows, I think, that the plan at present in use does not aid at all in securing an expression of the preference of the Society; because, as was illustrated in that case, while Mr. A had a plurality, yet he was far from securing a majority, and the result was, as I said before, to throw the election into this meeting, which was just what the plan was devised to prevent if possible. Now I do not think that we can get at a proper amendment in this meeting, but it seems to me that a committee ought to be appointed to draw an amendment to the Constitution. Perhaps it's not right to keep tinkering with the Constitution, but I believe it is our business as Civil Engineers to get things right if we possibly can. I would like to see a committee appointed to prepare some sort of an amendment so that we would have an opportunity to know who the leading candidates are, and not be obliged, as is now often the case, to throw our votes away. I would suggest two or three ways in which this can be done. In the first place, we might make this first ballot a ballot for nominations. That is, we could send out nomination blanks, on which any member of the Society could nominate a member, whomsoever he might choose, for any office. Then, when these blanks are counted, we might proceed in one or two different ways. For instance, we might specify a certain number of votes that it should be necessary a member should receive in order to be a candidate at the election. If a man receives as many as ten that he should be considered as a candidate for office; and that those receiving less than that number should not be regarded as candidates. I think, on the whole, that is a very good method, because, here is a man who may not be known generally to the Society, but he may be a good man, thoroughly qualified, and eight or ten of his friends can get together and, without any special wire-pulling, by just getting ten votes they can bring that man's name before the Society, and then the Society has the opportunity to accept or reject his candidacy as the members shall see fit; the choice being made from all of the candidates having more than ten votes in the nominating ballot.

The second method would be to take the two leading candidates and let them be the formal candidates for the final ballot. In that case there would be no question of an election by a majority and not by a plurality.

Then a third method would be to take three or four candidates, in which case you would have a plurality elect and not a majority. In two of these methods you would have a plurality; that is it would be possible in the first and third, but in any of them the election would never be thrown into this meeting. Each member of this Society would have a definite number of names, and would simply cross off from his ballot, of the names which were found eligible to run as candidates, such names as he wanted. I think it would simplify things a good deal and any one of these methods would have the advantage of relieving our annual meetings of having to go through with an election after the present elaborate system had failed to work.

THE PRESIDENT: Does anybody else care to discuss this question?

MR. TRACY: To bring this before the house I move that a committee be appointed to draw up an amendment to the Constitution in such a way so that it will permit the first ballot to be a ballot for the making of nominations for officers.

MR. KELLOGG: I would like to ask Mr. Tracy how the committee shall be appointed, by the present President, or by the incoming one, or by the house?

MR. TRACY: I should say by the present presiding officer.

MR. KELLOGG: And to be appointed now or in the future?

MR. TRACY: Now.

A MEMBER: I think the idea which the gentleman has just given is pretty good. It is true that under our present plan there is a great scattering of the votes. There are a good many candidates who have only one vote, and as Mr. Tracy says, these are practically thrown away. I should be heartily in favor of any plan which would prevent that, and which at the same time would help to prevent the election being thrown into the meeting.

MR. BUNCE: I was the instigator of the change somewhat largely, and was also the Chairman of the Nominating Committee. The reason that I felt as I did, and the committee very generally agreed with me in that feeling, was that practically you put the choice of the officers of this Society in the hands of five men. That committee nominated three men for a place,—I think it was,—and the result of the ballots last year confirmed our views of the matter entirely. It was the first man that we suggested in every case who was chosen by the ballots of the Society.

Another thing was that in certain cases we had the uncomfortable feeling of putting up men that we knew would be regarded simply as dummies. We had under the rules to put up so many men for an office, and yet we felt perfectly sure when we filled out the list that there was only one who stood any show of an election. For example, I would instance a case of Mr. Crandall. Mr. Crandall had been our Secretary and Treasurer for so many years that we knew it was the feeling of the Society that he should be kept in that position as long as he would hold it, and it seemed ridiculous for us to put up John Smith and somebody else as candidates for Secretary and Treasurer, when we knew that the members of the Society would look upon them as being put up there as dummies. It was that uncomfortable, unpleasant feeling upon our part, a feeling that all on that committee had that it was put in our hands to practically suggest the officers of this Society, and that is one reason why some change should be made. Personally, I am not at all wedded to that one idea. I am willing to have something else tried if it is going to be a success. It seems to me, however, that we are jumping out of the frying-pan into the fire a little bit quick. We do not know yet what the result of this ballot to-day is. While there may be a large number of scattering votes, yet the result of that ballot may be that you have by your ballots chosen an officer for every position. I do not know. It seems to me that it would be just as well to have the result of this ballot disclosed before we take action. I think then we can discuss this question more understandingly than we can now.

Mr. Tracy: I think the result of the adoption of such a principle as I have outlined will be much more satisfactory than our present practice. It seems to me that it is needless to argue the question, that under our present method the members are very much restricted in their choice. What I want, and what I think most of us want is the opportunity to choose, and it seems to me if we make this ballot of the Society a nominating ballot, it will be an entirely different thing and will be more satisfactory than our present practice.

Mr. Graves: Mr. President, I think that that idea of Mr. Tracy's to make the Society the nominating committee is a very good one. Of course, the detail of doing that, and the proceedings after the expression of opinion by the Society is received, is something that will have to be settled hereafter. It appears to me now to be somewhat cumbersome, but I recognize of course that the idea has not been fully worked out, and I think something will come out of it which will be an improvement. I like the idea anyhow and should like to see some effort made to apply it.

Mr. Bunce: Practically, this is a nominating ballot. The only difference, as I understand it, between the present method, and the one suggested by Mr. Tracy, is that the second ballot, if it is needed, will not be thrown into this meeting. This is really a nominating ballot and nothing else, and if it shows a preponderance of votes in favor of one man of course it would be very natural to take that man as the candidate of the Society.

A Member: There was an idea brought forward two years ago, I think, when this matter was discussed, that there was some question whether it was not better to have the ballot thrown into this meeting, as all the members who had taken the trouble to be here would then vote, and practically their votes should count for more than those of the members who stayed away.

Mr. Tracy: That has been thought of also. I believe when we meet in New Haven that we are about as apt to vote for a man in New Haven as in any other locality. So, too, at this meeting, which is usually held in Hartford, the majority of the attendants here are men who are going to vote, according to that principle, for men in Hartford. I do not think that the result of the adoption of this proposition will be to help to elect a man from any particular locality, and in the nominating ballot the members who do not attend will have the same voice.

MR. KELLOGG: I do not think that the argument that because a man is here his vote should count for more than a member who is not here, is very well founded. I think whatever plan we adopt should consider our absent members, because we all know that it is impossible a great many times for a man to be here, and it may not be his fault in any way.

THE PRESIDENT: Will you discuss this matter further, gentlemen? The motion is made and seconded that the Chair appoint a committee. I am not quite clear just how you worded that motion, Mr. Tracy. Will you please give me your motion again?

MR. TRACY: I move that a committee be appointed by the Chair to draw an amendment to the Constitution to the effect that this first ballot that we take may be a ballot for nomination and not for final election.

THE PRESIDENT: It has been moved and seconded that the Chair appoint a committee to prepare an amendment to the Constitution by which this first ballot shall be a nominating ballot, and not a ballot carrying a final election. All those in favor say aye.

Motion passed.

THE PRESIDENT: Mr. Tracy, did you intend to have that committee report at this meeting?

MR. TRACY: It is not necessary. The Chair knows best about that, of course.

THE PRESIDENT: The point made was, that if it was intended to have this amendment come before the Society at the next meeting it should be presented now.

A MEMBER: Couldn't this report be prepared before we come together this afternoon, so that the meeting would have a chance to discuss it a little further?

THE PRESIDENT: I think that's a good idea. I think that is a matter of detail which it may be well for the committee to work out.

The tellers will now read the vote for president for the ensuing year.

MR. HENDERSON: For President, the total number of votes cast is 74, of which Mr. F. L. Ford has 47, Mr. A. B. Hill 21, C. B. Vorce 5, and G. H. Sage 1.

THE PRESIDENT: The ballot shows that Mr. Frederick L. Ford has received a majority of the votes cast, and I hereby take pleasure in declaring him elected as President of the Connecticut Society of Civil Engineers for the ensuing year. I will appoint Mr. Graves a committee of one to go out and escort Mr. Ford to the hall.

MR. HENDERSON: For First Vice President, there were a total of 71 votes cast. Mr. John K. Punderford has 22, Mr. F. L. Ford 21, A. B. Hill 10, Mr. A. W. Sperry 4, D. S. Brinsmade 4, and 8 scattering.

THE PRESIDENT: There are 71 votes cast, of which Mr. John K. Punderford has 22, not a majority, and Mr. Ford has 21. The Society will, according to the Constitution, vote on the two highest names.

As Mr. Ford has been elected President however, I suppose you will have to vote him down for Vice President.

MR. BUNCE: I was just going to speak of that. I want to make inquiry, whether Mr. F. L. Ford's name, under the conditions, is not an ineligible name for a candidate? Still, a strict interpretation of the article would be that he should be voted for, but whether the vote should be between the two highest candidates with Mr. Ford's name excluded or otherwise I should like to know?

THE PRESIDENT: Well, I am not well enough up on parliamentary law to tell you whether that is so or not.

THE SECRETARY: There is only one candidate for the office in reality. Mr. Ford is not eligible to both places. It seems to me that the logical course is for Mr. Ford to be here and withdraw his name. That would leave the question then as to whether there was but one candidate before the meeting.

A MEMBER: The Constitution doesn't say that we should take the two highest. It says that the meeting shall then proceed to take a vote on the two highest numbers by ballot. I think it would be shorter if we could close this by voting to take the three highest members on the voting list. That would really bring two before the Society as really Mr. Ford is out of it.

MR. KELLOGG: Is that according to the amended Constitution?

A MEMBER: It's the one of April 20, 1901.

President-elect Ford enters the hall with Mr. Graves.

MR. FORD: Mr. President and Fellow Members: I fear that this is not the proper time for me to speak, and I do not intend to take up your time, but I simply wish to thank you for the confidence that you have reposed in me in electing me to this high office. I hope to discharge the duties during the year which is to follow in a way so that I shall be worthy to follow after the long line of presidents who have preceded me, and I hope that I shall have established at the end of my term as good a reputation as they have in the discharge of their duties. I hope that may be the feeling among the members of the Society one year from now. (Applause.)

MR. KELLOGG: Mr. President, if there is no motion before the house I would like to move that we ballot on the names of candidates for First Vice President, that is if it is necessary.

MR. FORD: I understand, Mr. President, that my name is before the house for First Vice President. I wish to withdraw it.

THE PRESIDENT: President Ford withdraws his name. The Society will proceed to ballot upon the names of Mr. Punderford and Mr. Hill.

MR. SNELL: I understand the Constitution to say that only the two highest names may be balloted for.

THE PRESIDENT: The candidates receiving the highest number of letter votes.

MR. SNELL: How many candidates?

MR. BUNCE: The two highest. That was the amendment.

THE PRESIDENT: As I understand it the amended Constitution reads in this way: That if no candidate receives a majority of votes for any office then the meeting shall proceed to vote for the two candidates receiving the highest number of letter ballots. Mr. Ford has withdrawn. So you will prepare your votes for A. B. Hill and John K. Punderford as candidates for First Vice President. I will appoint Mr. Graves and Mr. Clark as tellers.

MR. RYDER: Mr. President, I would say that I am authorized by Mr. Hill to withdraw his name.

The Secretary: There being but one candidate for the office of First Vice President, I move that the Secretary be authorized to cast the ballot of the Society.

Mr. Bunce: Second the motion.

The President: It is moved and seconded that the Secretary cast the ballot for Mr. John K. Punderford as First Vice President of the Society, he being the only candidate.

The Secretary casts the ballot.

The President: Mr. Punderford is hereby declared elected First Vice President of the Connecticut Society of Civil Engineers for the ensuing year.

Mr. Henderson: For Second Vice President the total number of votes cast is 65. Of these Mr. Punderford has 24, Theodore B. Ford 8, E. W. Bush 7, George K. Crandall 6, W. E. Johnson 3, J. L. Adams 3, Mr. Shepard B. Palmer 2, and 8 scattering.

The President: As Mr. Punderford has been elected First Vice President of the Society I think he should withdraw his name.

Mr. Punderford: I will withdraw my name, Mr. President.

The President: Then the two highest are Mr. E. W. Bush and Theodore B. Ford. You will prepare your ballots for them as candidates. Will the tellers, Mr. Clark and Mr. Graves, please count the vote.

Mr. Chandler: Mr. President, while this is being done I should like to offer the following, that the Secretary be and is hereby directed to cause a complete file of the Proceedings of this Society to be deposited at the Capitol Library in Hartford. Like most of the country members I went over the Capitol this morning, and Mr. Goddard at the library said that he was most anxious to have a file of the Proceedings of this Society. He asked me if I would not bring this matter up, or institute some proceeding which would result in having this file placed in the Capitol Library.

The President: I do not think that the Secretary has a complete file of the Proceedings.

The Secretary: I would say for the benefit of Mr. Chandler that I would like very much to comply with his wish, but I do not see how I can present a complete file, as there are a few different numbers which I have not.

Mr. Chandler: Of course, if we pass this vote the Secreta will not file anything that he has not, but perhaps he will able to get the missing numbers from some of our membe I am not sure but I can supply some of the numbers he is shc of myself. The fact that the Secretary has been unable to ke a complete file would seem to be a good reason why it wou be an excellent idea to have a complete set of these public tions filed with the State Librarian. I think it would be great convenience.

The Secretary: The Secretary has a complete file for t use of the Society, but I do not feel that I could give that the Capitol Library. That is to be retained for the Societ personal use. Outside of that the Secretary has not a comple file of our reports which he could file with anybody. There a a number of the years missing. '85 and '89 I believe, are mis ing, and there may be some others.

Mr. Chandler: I wouldn't wonder if I could supply tho myself.

The Secretary: If a file could be gotten together witho breaking into the one which the Society keeps for its own u I think it would be a good idea to have it placed in the Sta Library. If any of the members have any of the volumes those missing years I will be glad to receive them.

Mr. Manning: I would like to make an amendment to th motion, Mr. President. I think that a file of the Proceedin should be placed with the American Society. I would make amendment that at the same time the Secretary try and get a f of the reports for the American Society of Civil Engineers.

Mr. Chandler: I should like to accept that as an amendme to my motion with the understanding that our file shall con first.

The President: The motion is made by Mr. Chandler th the Secretary file in the Connecticut State Library and t American Society of Civil Engineers as complete a file as pos ble of the Proceedings of the Connecticut Society of Civil Eng neers.

A Member: I think that is well worded so far as it go but that there may be no question, why not put the words there that the Secretary shall file a second file? Then there be no question about it. It is to be a file as complete as possib but other than the one which the Secretary has for the use of the Society.

Mr. Chandler: I am willing to incorporate that in the motion.

The President: All those in favor of the amended motion signify in the usual manner.

Motion passed.

Mr. Kellogg: While we are counting the votes could we not have the report for the next office and perhaps save time?

The President: I do not see any objection to that.

Mr. Henderson: The next is for Secretary-Treasurer. The total number of votes cast, 69. Mr. Jackson has 67, C. M. Gallup 1, and Henry R. Buck 1.

The President: Mr. Jackson having received more than a majority of the votes cast, I hereby declare him elected Secretary-Treasurer of the Connecticut Society of Civil Engineers for the year 1903.

Mr. Henderson: For members of the Board of Direction. Total number of votes cast 132. Necessary for a choice 34. The candidate having the highest number of votes is Mr. E. D. Graves, who has 38, next is Mr. Henry J. Kellogg, who has 30 and T. B. Ford with 15. The rest of the ballots are scattering.

The President: Mr. Graves having received a majority vote as a member of the Board of Direction of the Society for two years is hereby declared elected.

Mr. Henry Kellogg of New Haven, and Theodore B. Ford of Bridgeport having received the next highest number of votes as members of the Board of Direction, but not enough to elect, the members will please prepare their ballots.

Mr. Bunce: Mr. Chairman, allow me to suggest that you are possibly going to encounter the same difficulty that we have just had in case it should prove that Mr. Theodore B. Ford has been elected Second Vice President.

The President: That is so. I did not think of that. Are the tellers ready to declare that vote?

Mr. Clark: The total number of votes cast for Second Vice President is 47, of which Mr. Theodore B. Ford has 25, and Mr. E. W. Bush 21.

The President: Mr. Ford is hereby declared elected as Second Vice President of the Connecticut Society of Civil Engineers for the ensuing year.

MR. GRAVES: That being the case, Mr. President, I move that the Secretary be instructed to cast one ballot as the unanimous vote of the Society for Mr. Henry J. Kellogg as member of the Board of Direction.

Motion seconded and passed.

Secretary casts the ballot.

THE PRESIDENT: I hereby declare Mr. Henry J. Kellogg elected as a member of the Board of Direction for two years.

Is there any more miscellaneous business to be presented to the Society at this time? If not, I will announce the committee which I was to appoint to prepare an amendment to the Constitution. On the committee to amend the Constitution as regards the making of a nominating ballot I will appoint Mr. Tracy, Mr. Graves, and Mr. Bunce. They will please make their report so that we can have it this afternoon after dinner.

MR. GRAVES: Before we adjourn, Mr. President, I want to say on behalf of the members of the golf club that the privileges of the club house are extended to the members of this Society, and we hope you will all make yourselves perfectly at home.

THE PRESIDENT: I suppose it is generally understood by the members that we are to go to the golf club for our dinner.

It only being ten minutes past twelve, I would say that Mr. Crawford has very kindly asked the members to visit the Grove street power house. They are putting in some concrete foundations there which it may be interesting to members to examine and we have nearly forty minutes to do it in before our car leaves here.

A motion to adjourn is now in order.

Motion to adjoin made, seconded and passed, and the convention declared adjourned to meet at the club house of the Hartford Golf Club at 1.30 P. M.

AFTERNOON SESSION.

After dinner at the golf club house the convention reassembled at 3.30 P. M., President C. B. Vorce in the chair.

THE PRESIDENT: The first business before the meeting is the report of the committee on this proposed amendment to the Constitution by Mr. Tracy, the Chairman.

MR. TRACY: Mr. Chairman, the committee on this amendment felt that it was something that ought not to be done hurriedly; that it was something that needed some time and care, so instead of presenting the amendment exactly as it should be we have simply drawn up an outline embodying that which we thought ought to be brought before you for discussion, and if these ideas meet with your approval to later embody them in a final draft. We feel that the details of carrying out this plan should be carefully thought out, and very carefully guarded, or worded so there can be no misunderstanding. We have therefore drawn up this plan as follows:

First, a nomination blank containing a list of the officers to be voted for, which shall be sent out by the Secretary to each member.

Second, that any member nominated for an office by not less than ten votes may be a candidate for that office.

Third, that the Secretary shall notify all members so nominated.

Fourth, that a ballot shall be sent to each member containing the names of the candidates for each office.

Fifth, the candidate receiving a plurality vote shall be declared elected.

I will add this by way of explanation. As to the first part, the nomination blanks, I think that is clear. The second part, we felt that instead of taking the three highest men, or the three men receiving the highest number of votes upon the ballot, we would put it this way, that any member receiving ten votes may be considered as a candidate. The reason for this was that it would enable us to get any man who was thought to be desirable, before the Society by a very little effort. It would then be possible to get a man before the Society by simply getting nine other men to nominate him, or it would afford an opportunity for that number of the friends of a particular man to get together and nominate him. It would do away with unnecessary wire-pulling, whereas under the present system, in order to get a man nominated he must be one of the first two or three, which necessitates a good deal of it.

The third clause was put in to provide for cases where a man who had ten votes might withdraw. Then, after this opportunity to withdraw had been given, the candidates names shall be printed in the ballot and this ballot sent out to the Society, so that after the ballot has been sent out there will be no withdrawing, and we will not have the thing get down to one candidate.

The fifth clause may receive some criticism. You will notice that we have provided there for a plurality vote,—the candidate receiving a plurality of the votes shall be declared elected. If there were more than two candidates it would be doubtful if any one of them would receive a majority of the votes cast, and in our judgment it seems as if it would be sufficient if a candidate received a plurality. That may not meet with the favor of all. I know in Connecticut we have had to wait a long time before the majority idea was overcome, but that is the way it seemed to the committee.

Mr. Bunce was a member of the committee and he may have some suggestion to make.

MR. BUNCE: I think you will see, gentlemen, without any trouble, that you have given the committee a good deal to do on very short notice. We, in considering this matter, felt that the best we could do was to draw up a skeleton plan such as Professor Tracy has given, and submit that to the meeting, leaving to us the opportunity to study the details, and a great many questions that will come up in order to put this matter formally into shape. I think as I look at the present situation, and the matter as it is before the committee, it will be necessary to draft a new fourth section. In order to do that there must be a good deal of thought and study put upon it. We had a little illustration to-day of the way that matter has worked. I do not think it could have suggested itself to anybody in getting up the plan which we followed to-day, that it would occur twice in the same meeting, that a man voted for, who was one of the two highest candidates for a lesser office, had already been elected to a higher office so that he was really out of the running. It was a matter that I never thought of, and I do not believe anybody that suggested that amendment ever thought that that matter might occur. There are a great many matters of that kind, matters of detail, which the committee must have time to carefully consider and work out. One is as to when these ballots should be sent out, and to whom they should be sent in return. When the second ballot should be sent out, and various matters of that kind. Now it seems to us almost impossible that this change can be accomplished in order to be operative at our next annual meeting unless there are two meetings of the Society between this and the next annual meeting, for the reason that the committee would not be willing, even if you should delegate the power to them, to suggest in all details this change of the Constitution. Our Constitution provides that any amendment to the Constitution shall be submitted at one of the regular meetings, signed by at least three members, and that the matter shall be opened for discussion and amendment at that meeting. The Society having acted upon it, it shall then be embodied into its final shape so that all at the next meeting may understand just what they are voting for. There is also a provision as to the Secretary sending it out for the information of the members. Now my idea is that our time will be very short in order to make it operative. In other words, there is no opportunity after the April meeting for changes to be suggested by the Society. Now we hope that this matter can be carried through this year in that way; that we shall have a spring meeting and a fall meeting. By the spring meeting we will be able to give to you this proposed amendment to the Constitution in all its details so that you may act upon it understandingly, and then it may be carried over so that at the meeting in the fall a vote may be obtained on the proposition. If that shall be our course during the coming year, we may be able to put it through after such full consideration as the importance of the matter deserves. We would ask, therefore, that the matter be continued in our hands for further study and suggestion.

Mr. Kellogg: One thing that suggested itself to my mind is as to this plurality idea. A plurality may put a man into office that is very far from getting a majority. I do not object to it now, but I would say that it strikes me, and undoubtedly it struck other members, as being possibly an objection to this proposed amendment. But I want to say that I am willing as one of the Society to let that go until the next meeting, so that I can have a chance to think it over in the meantime. Then we can discuss it and find out whether that point is all right. Of course anybody can see that there may be occasions where the plurality of a man may be a matter of a very small number of votes; a man having such a plurality would be elected and yet not represent anything like the number of votes which he would if he was obliged to obtain a majority. I am willing to leave it however, and I think most of the members are willing to leave it to a subsequent meeting to attend to. There is certainly a chance that if we have two meetings (which by the way will entail a little extra expense to the Society) the thing may be so well digested that we will be able to settle it then.

Mr. Jackson: In further continuation of Mr. Kellogg's remarks I would like to say that the probability is that the amendment will not be adopted this year. The probability is that there will not be a spring meeting. This meeting coming in February would necessarily oblige the spring meeting to come in May, or only about two months hence. In fact it is almost sure that we could not get the Society together for a successful meeting in two months from this time after having had our regular meeting now. In view of that fact I should respectfully urge that the committee as appointed to-day assume the responsibility of drawing up an amendment and that they further assume the responsibility of submitting that amendment for a vote at an intervening meeting between now and the next annual meeting so that this matter may be settled.

We have had proven to-day that the present method of electing our officers is practically a farce, and that some remedy is absolutely necessary before the next annual meeting. And, as I say, it is not probable that we can get this through for the next annual meeting unless the committee assumes some such responsibility. I think since the committee has outlined in general the policy that they intend to pursue, and that any member now has an opportunity to object, if he wishes, to any feature of their report he sees fit, it would not be asking too much of the committee to ask them to assume the responsibility of drawing up and submitting to the Society at the next meeting that is held, and there will probably be but one between now and the annual, this amendment to be voted upon. I think that would be a much better way to hasten action, and certainly I think we all agree that action is necessary. In fact, you might almost say there is a crying need for it.

MR. TRACY: I think the other member of the committee, Mr. Graves, and myself differ somewhat from the idea that Mr. Bunce has just given you. This is not strictly as yet an amendment to the Constitution because it is not in form. And, as Mr. Bunce says, it is provided that an amendment shall be presented at an annual meeting and signed by three members. It was my idea however, and I am quite sure it is Mr. Graves', that in doing as we have done we were practically complying with the spirit of the law, although in fact we have not as yet put the amendment in exact words. We have put essentially what it is proposed that the policy of the committee shall be in regard to the amendment into words, and that is before you. We have also provided that a notice shall be sent out giving information as to minor details which it has not been expedient for us to cover now, and we thought in view of that fact the Society would be willing to leave the matter in the committee's hands. So it seemed to us that this should be allowed to come in as an amendment, and that as such it should be voted on at the next meeting. I know it was the idea of both of us that in case there was no spring meeting yet that this amendment should be voted on before the next annual.

MR. BUNCE: The only thing that occurs to me, Mr. President, in this connection, or in connection with what Mr. Jackson has brought out, that possibly it could not be carried through to be operative at the next annual meeting, is this; that if the matter was left in the hands of the committee, and the suggestions which the committee may make, or the final form of this proposed amendment should not meet the views of the Society, why then all they have got to do is to vote it down, and the matter would still be open, and probably would not be delayed beyond another year. Suppose we should propose an amendment in complete form that the Society did not agree to? There has been no harm done if there are not two meetings. This thing cannot go through, of course, to be operative if the Society does not agree with the committee's report and it would have to come up again. If that should be the case why then we are not in any worse condition than we would be in the other case, except that the matter would not be settled in all probability for another year.

THE SECRETARY: I think the probability is that what the committee will propose will be a great deal better than the present method. Certainly, something should be done to remedy this trouble before we have to elect our officers again. I think whatever this committee may propose will certainly be an improvement. And I think that the committee should assume the responsibility.

MR. BUNCE: I think the committee, Mr. President, will be willing to have that responsibility put upon them if the Society so desires.

A MEMBER: It seems to me, Mr. President, that this matter is being exaggerated a little. It seems to me there is no great hurry. The officers that have just been elected are able to represent the Society. They are all good men even though they may not have been the absolute choice of every member, that is the absolute choice of a majority. I think while it may be necessary to make some change it would be well to make the change only after very careful consideration, so that we may make a change which will last, be a permanent thing, and not have to consider this matter in some form such as we have been doing for the last two or three years. I do not think we are going to suffer even if there is a little delay. I think it would be better to go a little slow. I think it is better to settle this thing right once for all than to have to spend all the time of our meeting in devising some new methods. I, for one, think it is better to continue the work of the committee and ask them to report at the next meeting, and to let this thing take as rapid a course as it can, but, at the same time, do not let it go so fast that we make another mistake and have to spend all of our time in trying to patch it up.

MR. KELLOGG: Mr. President, those come pretty near being my sentiments, and I move that the committee's report be accepted and the committee continued as they have asked to be.

Motion seconded.

THE SECRETARY: I move an amendment to that motion, Mr. President, to the effect that the committee be instructed to prepare ballots and submit the amendment to be voted on at the next meeting.

MR. NICHOLS: Make that a letter ballot, wouldn't you?

MR. BUNCE: Yes, it must be a letter ballot.

THE PRESIDENT: Do you accept that amendment, Mr. Kellogg?

MR. KELLOGG: I am willing to accept most anything.

THE PRESIDENT: The amendment to Mr. Kellogg's motion is that the committee formulate the amendment to the Constitution, and put it in such shape that it can be voted on at the next annual meeting.

THE SECRETARY: No, at the next meeting.

THE PRESIDENT: At the next meeting. All those in favor say "aye." Contrary minds. It is a vote.

THE SECRETARY: Then the motion as amended prevailed?

THE PRESIDENT: The motion as amended prevailed; that is, that the Committee is to formulate an amendment to the Constitution, and report so it can be voted on at the next meeting. I think that's right.

I think this finishes our business and we will now proceed to the literary part of our program. I take great pleasure in introducing Professor Alfred E. Burton of the Massachusetts Institute of Technology, who will give us a little talk on

"AN ECLIPSE EXPEDITION TO THE ISLAND OF SUMATRA."

Mr. Chairman and Gentlemen:—In the first place, gentlemen, I want to tell you that as a civil engineer, and a member of the Boston Society, I am very grateful for the opportunity of meeting the members of this Society at this time, and I appreciate the honor of being invited to speak to you. I know that I am here not on account of any personal merit, but rather on account of Mr. Vorce. He is an old student of mine, and when called up to recite I remember that he always made a bluff at it, whether he was ready to talk or not. And I am going to tell you how a civil engineer made a bluff at being an astronomer in 1901, and tried to get some photographs of the corona of the sun during a total eclipse, an eclipse which was visible in Sumatra and in that immediate vicinity.

The success of any such attempt depends a good deal on the weather. The chances are more than even, and particularly so in that tropical climate, that it will be cloudy when the astronomer reaches the place of observation, so that you can see that astronomers who are interested in this study of what can be seen about the sun when the bulk of the body of the sun is obscured, are extremely anxious that every moment of the totality shall be made the most of, and that accurate pictures as possible shall be taken in the hope that interesting and instructive scientific facts may be disclosed by the work of the camera.

"Tech" Eclipse Party while experiencing a "Hot Time" in Sumatra.

The expedition was placed in charge of the writer, and the members of the party were: Mr. George L. Hosmer, Instructor in Civil Engineering; Mr. Harrison W. Smith, class of '97, Instructor in the Department of Physics, and Mr. Gerard H. Matthes, class of '95, Assistant Hydrographer, United States Geological Survey. The last-named gentleman is a native Hollander, and a graduate of the Civil Engineering Department of the Institute. The securing of Mr. Matthes proved to be one of the wisest moves made in the outfitting of the expedition. His knowledge of the Dutch language and his acquaintance in official circles of Holland did much to pave the way for us in a land of strangers.

We left New York, February 24, on the North German Lloyd Steamer *"Werra,"* with an equipment of instruments weighing in all about four tons. Through the assistance of President Pritchett the party were able to secure from the Superintendent of the United States Coast and Geodetic Survey the half-second pendulum apparatus, which had already been used extensively in this country and Europe, for determining the relative values of the force of gravity at many different points. We were to swing these pendulums at a new station on the equator, in the Island of Sumatra, thus adding to the data for the determination of the figure of the earth. We were also to swing the pendulums at Singapore, at a station previously occupied by a United States government party using another type of pendulum. We carried with us a magnetometer and a dip circle, which were to be used in connection with a plan for simultaneous observations made in all parts of the world. These observations were to be made under the direction of Professor Bauer of the United States Coast and Geodetic Survey. This part of our outfit is mentioned first because it is important to show that the Institute of Technology was determined that its expedition should do some work which was not absolutely dependent upon the caprice of the weather; and it is interesting to note that the Institute party was practically the only one among the many gathered in Sumatra that made provision for doing scientific work not directly dependent on the clearness of the sky at a specified moment upon a certain day. For photographing the corona, Mr. Harrison W. Smith had devised special apparatus, consisting of four cameras. Three were of 11 feet focal length, and one of 40 inches. These were to be mounted in such a manner as to secure great steadiness and uniformity of motion. Two of the lenses in these cameras were loaned to us by Professor E. C. Pickering of Harvard College Observatory, and all were specially ground for photographic work by Mr. Carl Lundin, of Cambridge, Mass. For observing the times of contacts, we transported the five-inch equatorial telescope, the astronomical transit, and the chronograph from the Institute Geodetic Observatory.

By the steamer "*Werra*" the party sailed directly for Genoa, sighting the Azores, pausing a few minutes at Gibraltar and a few hours at Naples on the way. Four days of sight-seeing at Genoa, and then we embarked on the "*Koningin Regentes*" of the Dutch line running direct to Padang. The shifting of instruments at Genoa from one steamer to another was the only hazardous moment in the transportation of our outfit. This accomplished, we had simply to take our ease and "accept the universe," until the wooded hills of Sumatra should loom on our eastern horizon. For twenty-three days the "*Koningin Regentes*" was our home. For company we had Dutch and English astronomers, Dutch colonists returning to their homes after the usual recuperating trip to old Holland, young men seeking their fortune in a new world, and the annual output of officers and soldiers for the North Sumatra war; but not a solitary globe-trotter or tourist among them all.

The stewards were all Javanese boys, responding to the call of "Jongens." With bare feet and turbaned heads, they glided mysteriously about, and gave an Oriental flavor to the life of the ship. Absolutely ignorant of any words in English and knowing but few of Dutch, they managed in some occult way to anticipate our wants, and made excellent servants and waiters. Most of the Hollanders spoke English; and we were a fairly harmonious shipload of passengers, indulging in all the games and sports known to a steamer's deck.

We were favored with clear skies as we sailed close to the active volcano of Stromboli and passed through the Straits of Messena. We escaped Scylla and Charybdis, and were treated to a magnificent view of the mighty cone of Mount Ætna. A few hours for coaling at Port Said,—a little is quite enough of Port Said,—then in the night we steamed down the Suez Canal with an electric search-light at our bows, but were soon brought to a halt by the grounding of another steamer on the banks of the canal. For fourteen hours we were tied up within tantalizing distance of Cairo and the Pyramids, but with no possible means of escaping from the ship. To compensate for the loss of the Pyramids, we had the opportunity of experiencing a real sand-storm of the desert. The air was so thick with blowing dust that we had to seek refuge behind closed doors, the dry bulb thermometer at 98 degrees, the wet bulb at 68 degrees. It was of no use to try to pass the time in writing letters; the ink would dry on the pen before it struck the paper. Another night in the canal, and in the early morning we passed out into the arm of the Red Sea. Before long we realized that we were getting into the tropics, and gladly adopted the pajama costume for the early morning hours.

At the island of Perim the Dutch line vessels coal again for the run to Sumatra. Perim! No one would live on that island willingly, unless he felt it incumbent to prepare himself for a terrible future. Here for the first time we amused ourselves watching the boys diving for coins thrown from the steamer's deck. We were surfeited with this amusement before we reached home; but these saucy little Somalis were very entertaining, and their cry of "Oho, oho, à la mer," still rings in our ears.

Astronomy was not entirely forgotten on the voyage. We watched the new star in Perseus from the time we left New York, and recorded its fluctuations in brilliancy. We watched for and saw the "green ray" in the rising and setting sun, feasted our eyes on the stars new to us in the southern hemisphere, photographed our shadows when the sun was right above the mast, and finally, before landing at Padang, regaled ourselves with an astronomical dinner, the menu of which is here reproduced (p. 133).

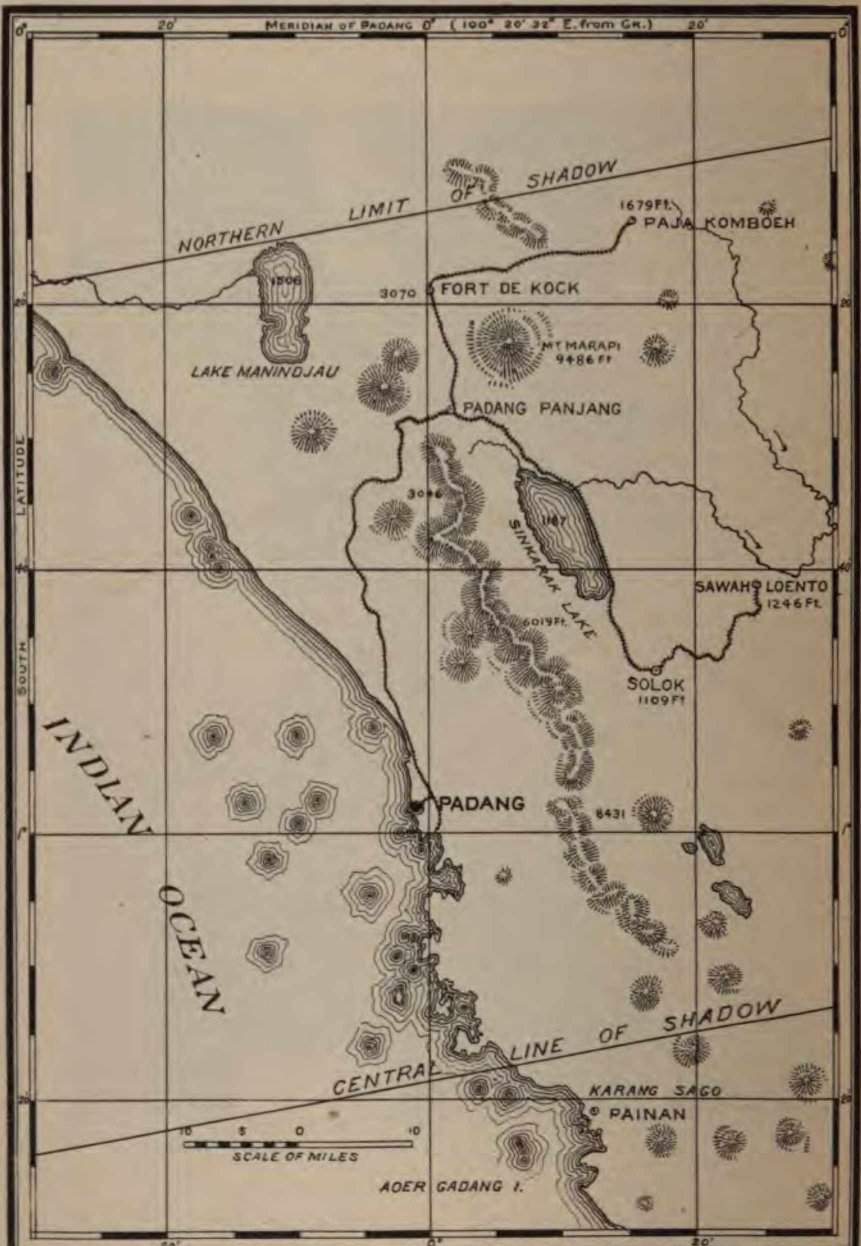
At Emmahaven we were astonished to see lying off the pier what at first glance seemed to be a steam yacht, flying the American flag. We learned that this was the United States gunboat "*General Alava*," formerly owned by Spain, which had brought the Naval and Smithsonian Observatory parties from Manila. They had reached this port by United States transport from San Francisco, and we were beaten by two days in our race around the world,—not to be wondered at, since we gave a good start. On the steamer's deck we were met by the Governor of Sumatra, by Colonel Müller, in charge of the topographical survey of the island, and last, but not least, by our most worthy consular agent, Mr. Veth, of the firm Gebrüders Veth, Padang. Whatever may be said about our consular service in general, the consular agent at Sumatra is an honor to his calling. He outdid our wildest dreams of hospitality. After seeing our precious freight on the wharf, he took us in his carriage over the lonely road to the city, and landed us at the new hotel in rooms reserved for our especial accommodation. That was a picturesque ride at night over the dark, jungle-bordered road; and our nerves were kept at the proper tingle by stories of recent tiger raids on "this very spot." Alas! the tigers we imagined that night were the only tigers we ever saw.

At ten o'clock the next morning, according to colonial custom, we reported at the governor's mansion in full evening dress. After a gracious welcome we were introduced to Mr. Delprat, the engineer and manager of the railroad connecting Padang with the coal mines in the interior.

Before leaving Boston, we had selected, after a careful study of maps and astronomical reports, the exact place we wished to occupy with our instruments. It was a spot in this region of perpetual rain where the sun had been seen at noon during every day but one in the previous month of May. It was the village of Solok. Again the Naval Observatory party were ahead of us. They were already located there, and had secured all available accommodations; but fate was kinder than we knew.

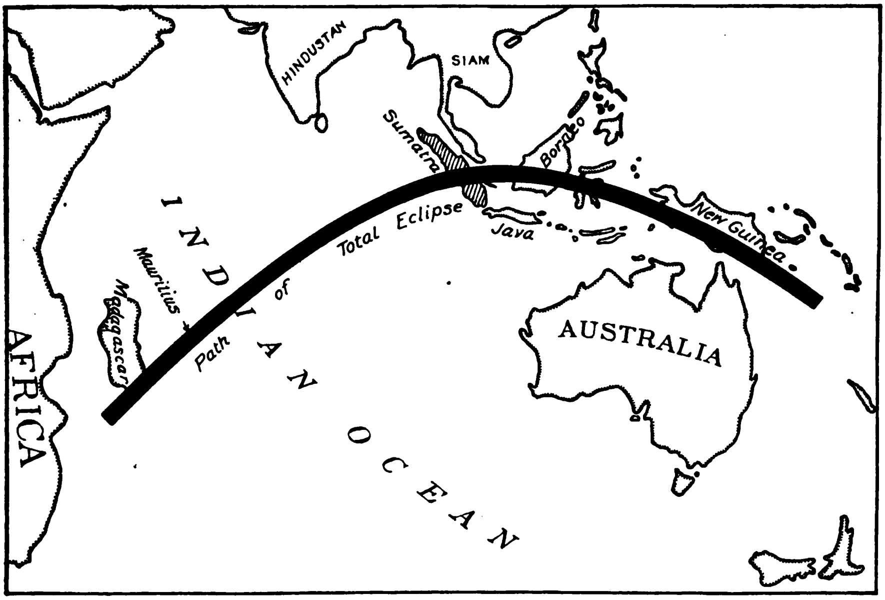
On consultation with Mr. Delprat, we decided to go to the last station on the railroad line, up into the hills of Sawah Loento, to the coal mines. Here we found a little hotel newly

Street in Padang.



Map Showing Locations of all the Eclipse Expeditions to the West Coast of Sumatra.

erected for the accommodation of official visitors, an excellent site for the instruments, and materials and labor in abundance; but, best of all, on the day of the eclipse we were able to photograph the corona, which we could not have done had we been shut in by the clouds at Solok on that eventful day. The twelve hours' journey by rail from Padang is among the choicest memories of our whole tour of the world. This journey and a side excursion to the heights of Fort de Kock and the village of Paja Kombo gave us our glimpses of native Malay life.



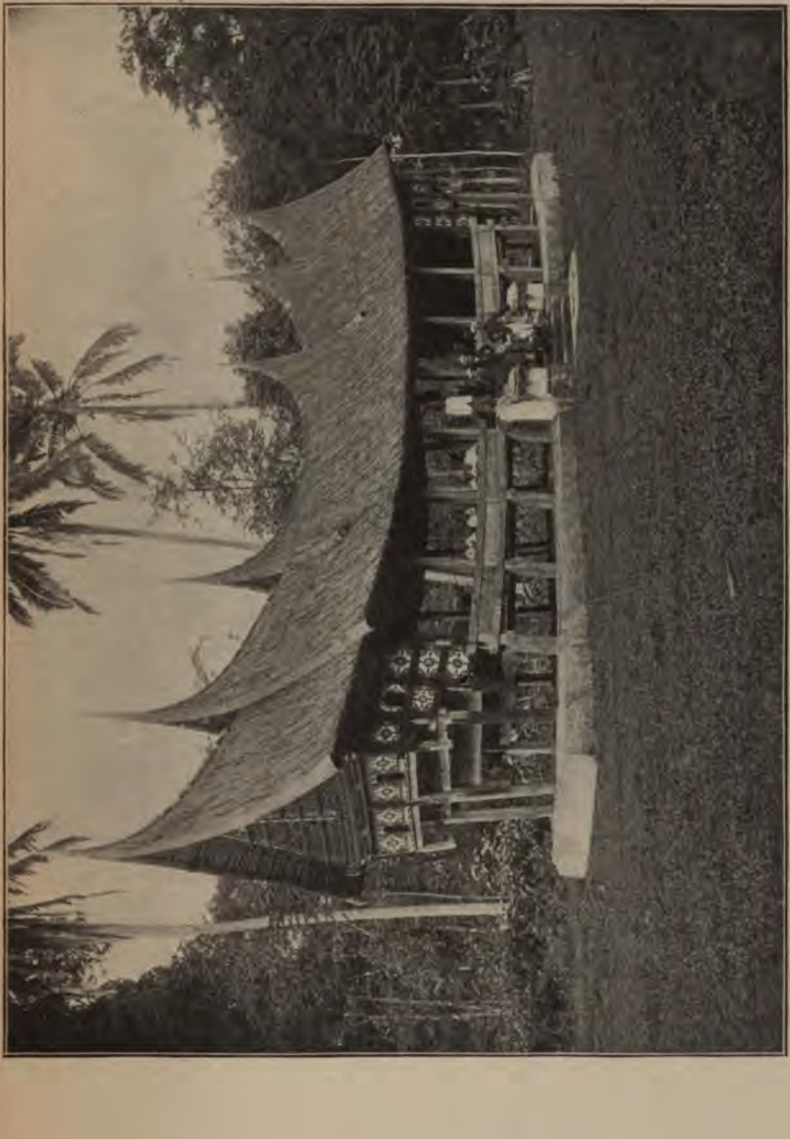
Path of the Eclipse.

What a delight it is, when you go to a tropical country, to find it just as hot as it ought to be, and, when you come to the jungle, to find it just as tangled, rank, and impenetrable as you dreamed it! As we went farther and farther from the coast line we found ourselves penetrating deeper and deeper into a Malay civilization for which our geographies had not prepared us. Here were costumes and architectural effects far different from the hackneyed cuts in books of Eastern travel.

There are two classes in the Malay civilization,—an aristocracy that commands and a laboring class that obeys. The laborers were feudal slaves until the advent of the Dutch; and now, though straightening up to independence, they still regard with awe their former lords. The Malay as we found him in Sumatra, to whatever class he might belong, had more of individuality and dignity than the average Oriental. He held his head erect, and looked one squarely in the eye, in marked contrast to the fawning of the Javanese. These Malays of the interior are of pure stock, and have only contempt for their smaller Javanese brothers. With shrewd diplomacy the Dutch avail themselves of this race prejudice. They find an open camp of Javanese convicts in the hills of Sumatra better guarded than a fortress in the island of Java. Let one of the prisoners try to escape, his freedom is short. Soon he comes crawling back with a string around his neck, goaded on by the taunting and contemptuous Malay.

I show you this picture (p. 139) because it gives you a new idea of this country. The interior of Sumatra is very rarely visited, and not a great deal has been written about it; but there is a certain interest to this picture to which I want to call your attention. This is the town hall. We came upon this after we had proceeded upon our journey up into the interior some little way. You see we were getting away from the Dutch influence of the towns, and getting up into the region where there was more independence among the natives. This is an assemblage of the natives of that class. These natives have come together to discuss questions of concern to them in their affairs with others. In this particular region where this picture was taken they are more independent than they are in Java. They have their own rajahs and hereditary officers, but even though this is the case, the people seem to think that they have a right to discuss the questions that come up. They do not seem to like to have anything decided without they have had an opportunity to come together and talk it over. So these assembly rooms are found in every district.

You will see from the picture that these structures are built somewhat peculiarly. They slope out at the base. Notice also the coloring. In order to understand it well you must realize that all that shows black is red, and all that shows white is light blue. Notice also how they put in the foundation. All of the beams rest upon foundation stones. The reason for



Malay Council House, or "Balei," Upper District, Padang.

this is that they are beset with white ants. These eat into the wood, but the white ant has to have its nest in the ground. Now to get from the ground to the bottom of the beam they have to pass over the foundation stone, which they are very loath to do. They work in the interior of the wood and away from the light, and are very averse to passing from the seclusion of their nests to this part of the beam, because it exposes them.

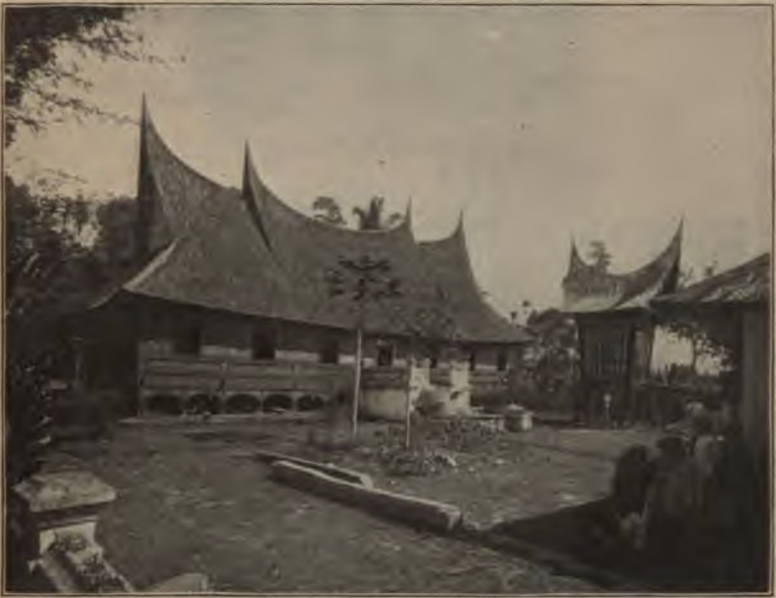
The next view (p. 141) shows a house of a well-to-do rajah. You will notice the building is not at all affected by the Dutch order of things. This is a very fair representation. These people are all quite well-educated Malays, as they have had the benefit of the instructions of the Arabian and Indian priests.

Notice the peculiar construction of the house, and the way these wings are added to it. The reason for this is: this man had a number of daughters, and one of their peculiar marriage customs is that the husband of the daughter shall come home and live with the daughter in the father's house. These people do not have many wives, as is the case in some other countries that we know. Polygamy is not usually practiced among them. As a rule they have but one wife, but these wives are very easily divorced, and then the husband can get another. Their system gives them the benefit of a variety of choices. Now the father whose daughter marries adds a piece on to the original house in the way you see in the picture. They are not very careful how they put the additions on, that is, with reference to the architectural effect, or appearance of the building. You will notice from the picture that this man had three daughters married, and he has settled two of them on one side of the house and only one on the other. This is a very peculiar custom, but it is a fact that they do add these additions to the house with each succeeding marriage. Whether they follow that out literally in all cases I do not know. I should not think it could be done, but I was informed that it was usually the custom for the father to enlarge the house for every marriage.

I want to show you this rice house, because I think that is interesting as a type of artistic work. Everything about it is well conceived. The whole thing is well designed. It is made of wood. The installation of the supports is very well done, and the whole thing is a fine piece of architectural design.

There were many of these that we saw that were used simply for the storage of rice.

As we travelled from Padang to the hills, we passed long processions of the people on their way to the weekly markets. They often walked twenty miles, the master of the household, his family, and all the servants trudging along in the very early hours of the morning to spend a whole day in traffic and chatter. The women servants carry all bundles, from a bunch of bananas to a bushel of rice, upon their heads. This method of travel is not rapid, but might be called a quick express when compared with the journeying by "water buffalo," or "kerbau." The movement of the "kerbau" is the most deliberate thing we ever saw. The wonderful way in which this great, hippopotamus-like creature has adapted himself to the peculiar climatic environment in which his lot has been cast, commands one's admiration. There is always a look of contentment in his sleepy eyes; and, when one hears the traditional necessities for



Malay House and Rice Barn.

his comfort which he has caused to become laws among his masters, one also realizes that he has a quiet sense of humor.

On the Way to Market.

Water Buffalo, or "Kerbau."

He must have two baths a day, no matter what happens. For instance, we start a load of bricks for the building of the piers at our station. After we have gone two miles, the hour of the bath approaches. The bricks are dumped. The "kerbau" is unhitched, led back three miles to the river for a bath, which he takes in a leisurely, luxurious manner, and returns again to the work after a four-hour siesta. Every householder that keeps a "kerbau" has a bath-tub excavated in the mud near the house. If you chance upon him at the moment when he is enjoying this Sybaritic luxury and if you are in sympathetic

Malay Gentleman in Full Dress.

mood, he will be sure to bestow upon you a knowing wink as subtle as the smile of Buddha.

The view on page 143 shows you a gentleman of this region. There are several things about this which are interesting in connection with these people. One is that they never drink any spirituous liquors. They are strict in that respect. All the drinks that they have other than pure water were like raspberry syrup and similar beverages. This fellow is something of a dandy. You will notice that he is not smoking a cigar. He is chewing a leaf with a betel-nut in it. They chew that instead of tobacco. They are also inveterate smokers, using little cigarettes for that purpose. Whenever they chew these leaves there is a juice produced which is very bright red in color. When this is spat out the red stain is very readily seen, and you can therefore always tell when a party of them has gone by.

This was one of the most important individuals in that section. He is in full regalia. They never wear anything on their feet, and they never take off their head gear.

Page 145 shows a number of ladies that did not object to having their pictures taken. Whatever else they may not have had on, they had a great deal of jewelry, which is rather interesting, as I shall explain to you. It was somewhat of a surprise to us to find the natives with so much jewelry. The reason for it is that there is a great deal of gold in Sumatra, and that is, probably, why they do not want the Dutch, or other people, to explore the islands. The Malays themselves are rather indifferent to it, but at the same time they do not want others to come in and explore the country and work the mines. There was one settlement up in the mountains, very near where we were, where it was well known there was a deposit of gold. We were told that the metal was frequently washed out by the rains, and in the streets there is also likely to be some gold found. I saw one man who came down from that region. He was a Dutchman and he had picked up several nuggets of gold. They will not allow the Dutch, however, to work that mine. They are very superstitious and probably think that some calamity will befall them if the mines are worked.

Their ornaments are of pure gold. It was rather a joke on us, for when we went out we took a plentiful supply of glass beads with us as we thought that these tawdry ornaments would go in Sumatra in our intercourse with the natives, as they are said to do in the South Sea Islands. We had quite a little stock of them, and yet about the first native that we found up in this region had on enough gold to pay for the expedition.

The view (p. 146) shows us at work. We could not get any native help. They would not labor for pay, so we were obliged to get the Dutch to help us. They let us have the benefit of their convict labor station near the gold mines. They are not a very prepossessing looking lot, but they were the best we could get. They were able to do some work, and with their aid we succeeded in getting our station in working order. They were terribly slow in their operations; still it was better for us to employ them and to look on in that hot climate, for you must remember we were practically on the equator. The heat averaged 90 degrees, a little more than that sometimes. It was intensely hot. Even at night, when the heat was tempered a little by the setting of the sun, the temperature would range between 75 and 80 degrees. Sometimes it will get down

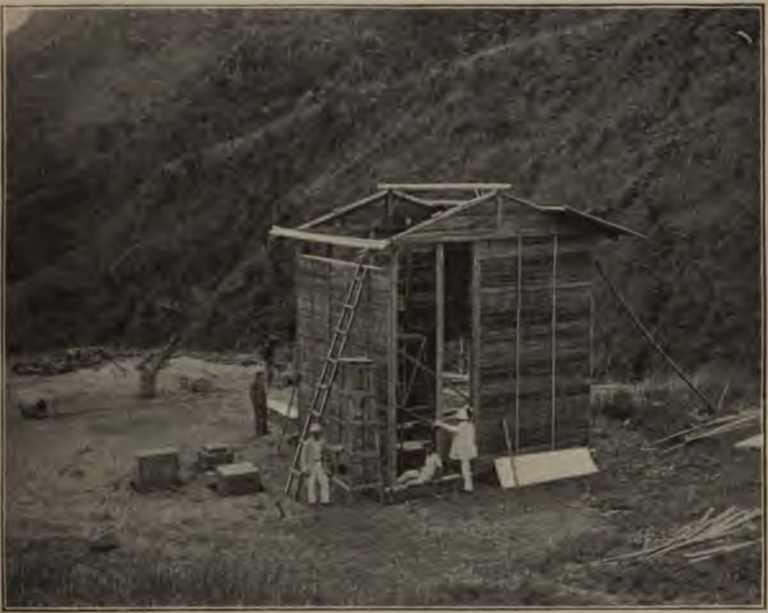
Native Malay Women at Paja Kombo.

as low as 75, but it was generally about 80 or 90 all the time, so it was a very good thing for us to be able to get this labor. In this connection I want to tell you about an ingenious thing connected with the management of this convict labor system. The Malays of Sumatra hate the Atchinese. When the Dutch want to have any of these men work they send their convicts from Java up there, and these convicts from Java are better guarded out there in that open field in Sumatra than they would be in a state prison, because this feeling that exists among the Malays is well known to the prisoners and none of them try to escape, knowing they would surely be captured by the natives and brought in. The Dutch government has availed itself of this feeling between the two classes as a means for

Work at M. I. T. Station, April 17th.

guarding the men. The Malays of Sumatra, whenever the Atchinese escape in that region, are sure to find them and bring them in.

This shows where they are at work building the tower. They were very, very slow. It was quite discouraging watching the work rise. We had about a month. We started the last of February, and we reached Sumatra in April, and the eclipse took place on May 18. Although we kept steadily at work after we got there every day we did not get it all ready until the day before the eclipse.

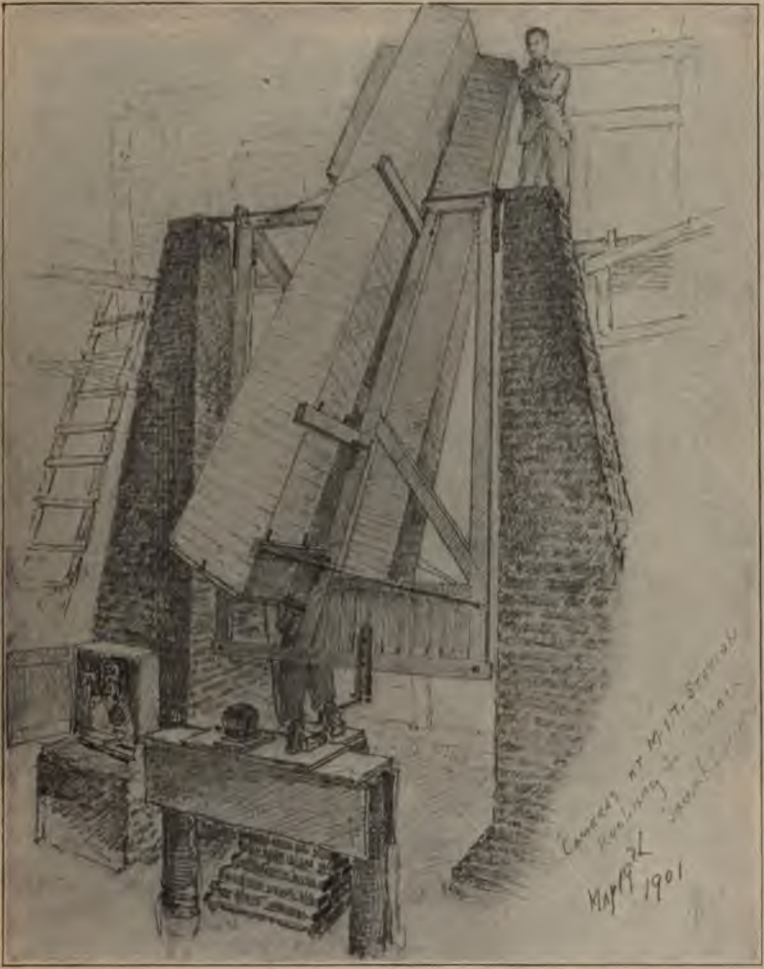


Building erected to shelter the Eleven-feet Cameras. Piers for Astronomical Transit and Pendulum Apparatus.

Page 148 shows our completed station. Two heavy brick piers, four feet underground and eleven feet above, had to be constructed to support the polar axis of the camera frame Then five more brick piers for the transit, the chronograph, and the pendulum apparatus. We did not have very much engineering work to do. About all of the work of that character that we had was to put up the piers or supports for our instruments. We put up here the instrument by which we could determine the exact latitude of the place. We had other instruments by which we could observe the times of contact,—when the edge of the moon approached the disc of the sun and also instruments for accurately recording time. Also in our outfit we had apparatus for photographing the corona.

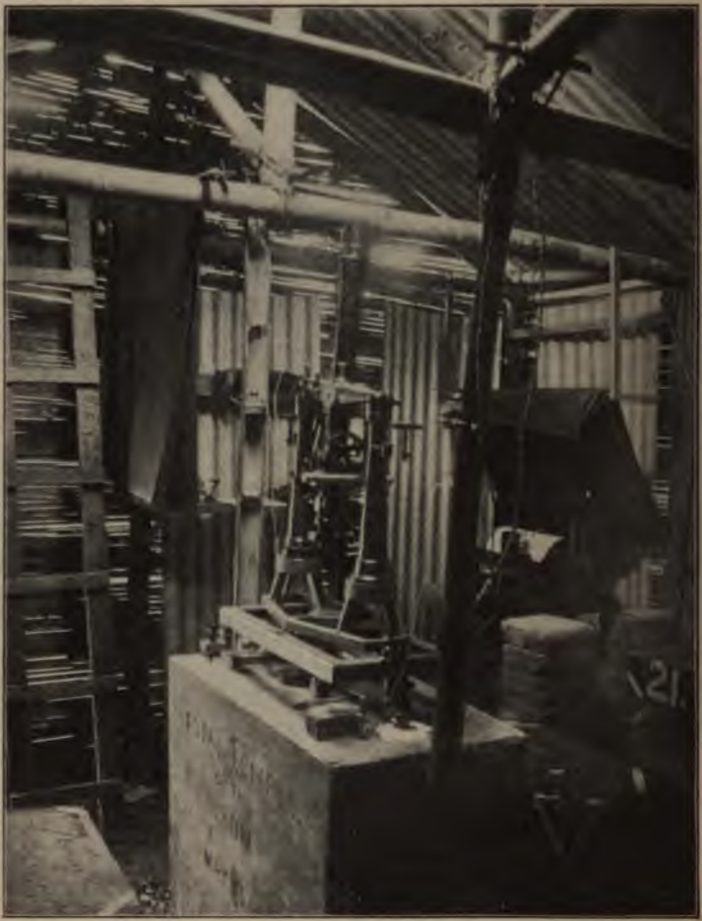
General View of the Station on the Day before the *Eclipse.*

On p. 149 is a sketch in part, because I could not get the whole thing into one photograph. We put up these piers of brick. We were able to get a very good foundation so there was no vibration. They are constructed entirely of brick and cement. Across the top we had a steel axis. This axis was parallel to the axis of the earth. Then we had a frame attached to that so arranged that we could place the cameras upon it. These cameras had to be about 12 feet long in order to get an effective picture of the sun. An ordinary camera would make a



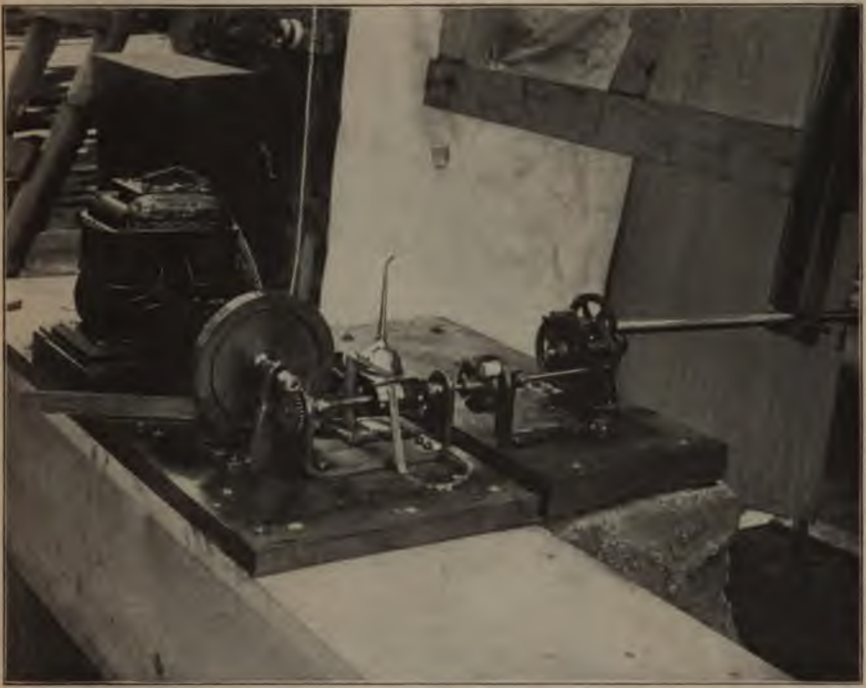
Sketch showing Method of Mounting Cameras.

picture under such circumstances about as large as the head of a pin. These cameras, as I say, were attached to the frame. There were three cameras, and they were so placed upon the frame that they could be moved when the frame was moved. We could open them at the top by means of an assistant, and we could put in the plates at the other end. We planned to take as many photographs as possible during the six minutes of the eclipse. We were intending to take five or six photographs in each one of these cameras. Our aim was to have a series of pictures showing the whole course of the eclipse, including one showing the moment of contact, and then showing the progress



Transit and Chronograph at Sawah Loento Station.

of the event as it proceeded. This whole arrangement had been planned so that it would move exactly with the sun. We had a screw attached to the lower part of the frame swinging on the axis, and that was run by a little electric motor controlled by clock-work. It was all very carefully adjusted and we were perfectly positive it would do the work very well indeed, and it did do so.



Controlled Motor and Tangent Screw.

This apparatus (p. 150) was on an entirely separate pier, and the whole success of our work, I think, was due to the very careful manner in which its erection was planned and carried out.

The above view shows the lower part of the same frame, the clock-work and the little electric motor which supplied the power.

This (page 152) is where we had our magnetometer. Of course it was necessary that the apparatus should be as free as possible from the influence of any metallic substance. Our observation showed that there was a little deflection of the magnetic needle. We did not find much of any account, but still our observation, compared with others, seemed to point to the fact that there was a disturbance of a slight character.

Magnetometer Shelter.

In connection with this, perhaps you will be interested to hear the story of an experience that one of our party had with a tiger. This building was separated from our camp and we had to go up, from one to the other. We found that our Malay servant would not go alone and we wondered why. We ascertained that they did not like to go up there at night, because

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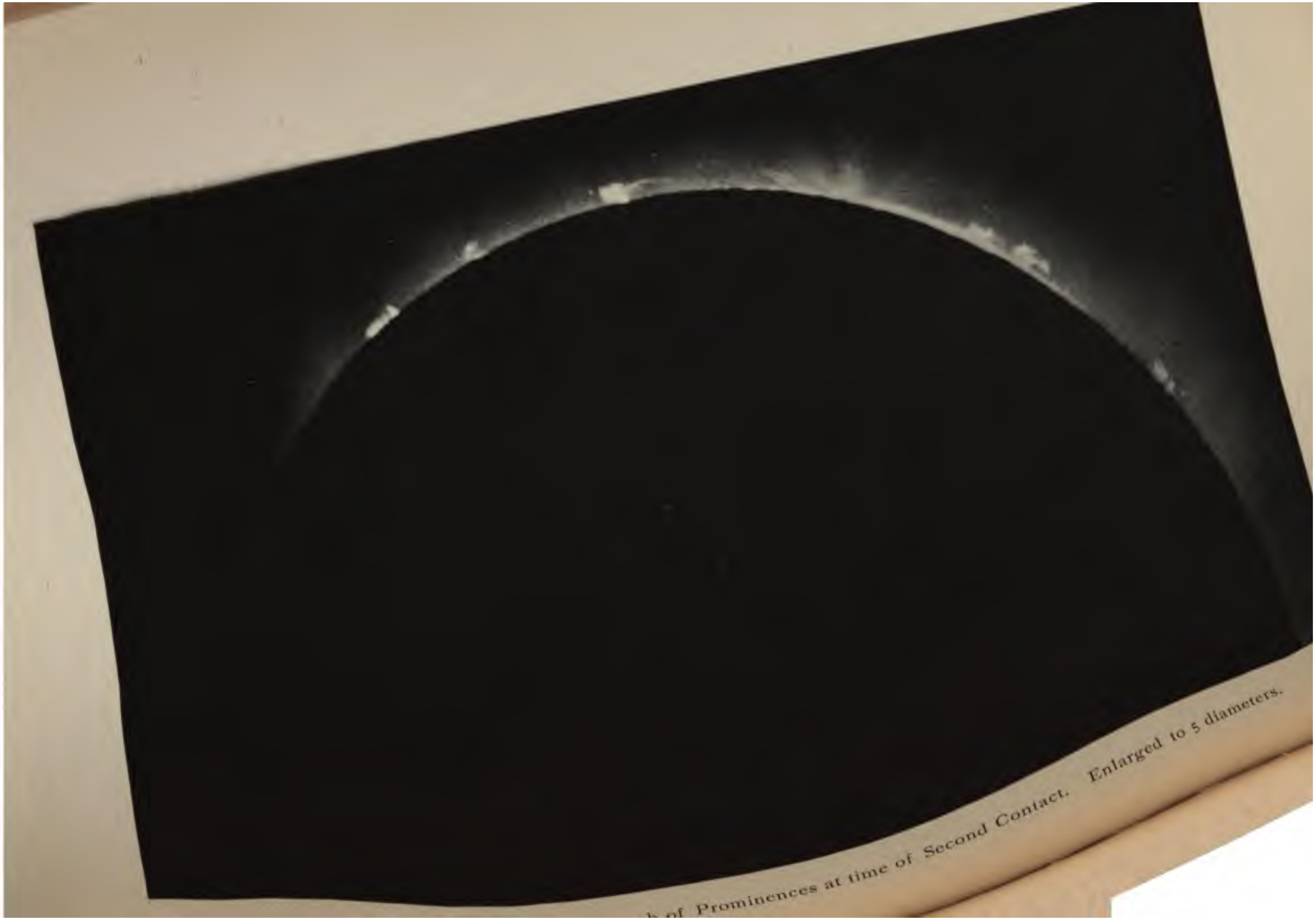


h of Prominences at time of Second Contact. Enlarged to 5 diameters.

there were tigers around. When we went up they used to tag right on our heels. One night the photographer in our party stayed up there alone, and he tells this story. "He said that he had just got through and had started to come down—the day before we had heard some growling in the woods near by—when he reached a point where the path led under an undergrowth of trees: he looked to his right and saw two bright points of light. He thought at once they were the eyes of a tiger, and his hair went right up on ends. As he looked at them he remembered that the tiger was afraid of light. He was sure it was a tiger. He didn't have any courage to run or do anything except stand still and look, and as he looked, to his surprise the two points of light drew further and further apart and he was imagining the size of the tiger. As the two points continued to separate he began to think there was something queer about it, and to get cool again; then he went up and picked up a couple of glow worms on the bank." That is the only real tiger story that we have.

On account of the rain and the sun, protecting buildings had to be erected, and a non-magnetic shelter had to be placed on the neighboring mountain to provide for the magnetometer. When these things were finished, the convicts were dismissed.

A set of pendulum observations was made by Mr. Hosmer, and all was in readiness on the day of the eclipse. This day dawned cloudy, but the sky cleared at the time of the approach of the first contact. We recorded the time of this first moment with hopeful spirits. Then, as the real event approached, the sky covered itself with a filmy, tantalizing lace-work of clouds. It was a sky to make an astronomer frantic with apprehension and hope. Nearly six minutes of totality and mental agony now transpired. Every detail of the programme was carried through with accuracy and despatch; but not until after three sleepless nights of constant work in the development of the photographic plates was the strain of uncertainty removed. For photographic results Mr. Smith had one fine picture of the corona (twenty seconds' exposure), an excellent representation of the sun's prominences at the time of second contact (half-second exposure), and several plates of long exposure made with the idea of revealing a possible intra-mercurial planet. Record had been made of the times of the four contacts, and the magnetometer programme was carried out without interruption. The American parties at Solok, and the Dutch, French, Russian, and Japanese expeditions were not so fortunate in the weather conditions. Some of the Naval Observatory party at Fort de Kock, the Lick Observatory party at Padang, and the English on the island just off the coast of Sumatra, had quite as good or even better weather. Near us at Sawah Loento was the English station, in charge of Mr. H. F. Newall, of Cambridge, and two observers from the Naval Observatory party were located close at hand.

As soon as the plates were developed, the packing up began; and in a few days we were back in Padang, ready for the next steamer to take us to Batavia on our way to the pendulum work in Singapore. Everything but the pendulum and the time instruments were sent back from Padang directly to New York. At Batavia close connections was made with the steamers of the "Koninklijke Paketvaarte-Maatschappij." After four days we were installed at "Raffles" in Singapore. There was not appreciably much change of climate. We were now about one degree north of the equator. At Sawah Loento we had been ½ degree south. The sun still rose at six in the morning, and set precisely at six in the evening. The change from darkness to sunlight and from sunlight to darkness was just as short and surprising. Flowers and trees were blossoming and fruit was being gathered all at the same time. Centipedes still crawled around on the bath-room floor, and our clothes and shoes gathered a coating of mould over night. In many ways we felt quite at home except that our neighbors were new. Instead of the Dutch and Malays there were now the English, Chinese, Singalese, Hindoos, and Sikhs, with a sprinkling from the rest of the world. In Singapore we ceased to be athletic, yielded to the inevitable, and appeared in public only in the 'rikshaw. Mr. Matthes and Mr. Smith took the next connecting steamer for China and Japan, while Mr. Hosmer and the writer devoted themselves for two weeks to the pendulum. Through the kindness of Mr. S. Symonds Fry, in charge of the Time Service at this port, we were allowed to use the local observatory; and the observations were satisfactorily completed. When the pendulum outfit was packed for its journey home, we breathed the free breath of the irresponsible tourist, and began to seek acquaintance with the other half of the world.

On the steamer "*Bayern*" of the German Mail we started north through the China Sea, and were favored with the first typhoon of the season. At Hong Kong there was just time to ascend to the Peak, and to realize the depressing effect of a threatening epidemic of plague; then we were off again to North China and the harbor of Wu Sung. At Wu Sung we took a river steamer to Shanghai. While dining at the Astor House in the European concession, we were met by Mr. Murray Warner, graduate of the class of '92, and through his kindness were introduced to a Chinese mandarin. Mr. Warner and the mandarin showed us over the ancient Chinese town. Here we seemed to see the Chinaman at his worst and best,—at his worst in the narrow, filthy streets and tea-houses, at his best in the Mandarin Club. With many regrets, we left our kind host at Shanghai, and steamed to Nagasaki, where we had our first glimpse of picturesque Japan. Although things change rapidly in our Western country, we can hardly keep pace with the rapid transformation now going on in this land of the "Yankees of the East." Nagasaki is far from being the town described by early travellers; and any one who visits Japan now with expectations based upon books of travel of even ten years ago will have to go far inland to find the conditions there described. Nevertheless, it is picturesque, strange, and enjoyable enough. In the Inland Sea the sky was overcast, but the mist-shrouded islands were exactly those so familiar in Japanese drawings. At Kobe we found Mr. Smith and all the members of the Institute party who last summer made the trip to Japan. Continuing on to Yokohoma by water, we had the great good fortune to catch a glimpse of snow-capped Fujiyama hanging high above the mist-hidden land.

Mr. Fukuzawa, of the class of '88, took us in hand at Tokio; and under his guidance we had a glimpse of the Japanese life of the present day. We could easily see that Mr. Fukuzawa and his newspaper, the *Fiji Shimpo,* were real factors in the growth of "New Japan." It was also a great pleasure to find this energetic and progressive man a loyal son of Tech.

After a delightfully crowded week we took passage on "*The America Maru*" of the "Toyo Kisen Kaisha" line for San Francisco by way of Honolulu. The voyage was not eventful, and was interrupted only by a half-day's stop at Honolulu, which gave us time for a few short excursions; and when, after seventeen days' sailing, we came through the Golden Gate, we felt as though we must have reached home, although still five days from the gilded dome.

NOTE.—The Society wishes to acknowledge its indebtedness to the *Technology Review* and the *Technology Quarterly* for the use of cuts and descriptions in making up this article.

THE PRESIDENT: Now gentlemen, if there are any questions that you would like to ask, I am very sure Professor Burton will be glad to answer them.

If there are no questions, the next paper will be by Mr. Crawford on the "Constituent Parts of Concrete." I hope, after this paper, that every member will avail himself of the time which will be given to its discussion.

THE CONSTITUENT PARTS OF CONCRETE.

GENTLEMEN:—The fact that different engineers attempt to produce the same result by widely differing mixtures, has repeatedly been brought to my attention in reading the various specifications for concrete that I have been called upon to examine during the past few years, some for work on which I have submitted estimates, and some which I have only read as a matter of interest.

I first heard from Mr. Vorce by telephone when he was so kind as to ask me to furnish some data regarding the constituent parts of concrete, with a view of starting a discussion on the subject. Not knowing what to do next, I immediately hurried to the bookcase and opened the encyclopedia. The first thing that confronted me was the derivation of the word concrete—"concrescere"—to grow together. This expresses the whole matter to me in a nutshell. If your concrete "grows together" in good shape, all is well, but if not, look out for trouble.

Prof. Ira C. Baker in his "Treatise on Masonry Construction" states:- "The voids in the aggregate should be filled with mortar. If there is not enough mortar to fill the voids, the concrete will be weak and porous. On the other hand, more mortar than enough to fill the voids of the aggregate increases the cost of the concrete and also decreases its strength. The decrease in strength due to an excess of mortar is usually greater than would be produced by substituting the same amount of aggregate, since ordinarily the sand and the aggregate have approximately the same per cent. of voids, while the sand has the greater, and also the smoother surface.

A correctly proportioned concrete is always stronger than the mortar alone."

He then gives the crushing strength per square inch for Portland cement mortar and concrete, each twenty-eight days old, as follows: One to two mortar, 2158 lbs. With three parts of pebbles, 2783 lbs. With five parts of pebbles, 2414 lbs.

One to three mortar, 1406 lbs. With five parts of pebbles, 1661 lbs. With six and one-half parts of pebbles, 1534 lbs.

One to four mortar, 1068 lbs. With five parts of pebbles, 1291 lbs. With eight and one-half parts of pebbles, 1221 lbs.

Prof. Baker also states "for the strongest and densest concrete, the voids of the aggregate should be filled with a rich strong mortar; but if a cheaper concrete is desired, fill the voids of the aggregate with sand and add as much cement as the cost will justify. In other words, to make a cheap concrete use as lean a mortar as the circumstances warrant, but use enough of it to fill the voids in the aggregate. Sand is so cheap that there is no appreciable saving by omitting it; and the use of it makes the concrete more dense."

In the specification of a concrete dam recently built in this State, and described in the Proceedings of this Society for the year 1900, on page 163, the proportions were set forth as follows:

For body of dam and abutments, one part of Portland cement, three parts of sand and three parts of broken stone. For twelve inches on the outside face of the dam, one part Portland cement, three parts sand and two parts of broken stone.

From Prof. Baker's results, above referred to, the structural value of these mixtures would be about as given below, and the cost would also be about as stated; both structural value and cost being compared with a 1–2–4 mixture.

	Structural Value.	Cost.
1–2–4	1.00	1.00
1–3–3	0.60	1.21
1–3–2	0.58	1.64

On the same basis even a 1-3-6 mixture would show a relative structural value of 0.615, being stronger than either of the mixtures specified, but the cost would be 87 per cent. of the 1-2-4 mixture, 72 per cent. of the 1-3-3 mixture, and 56 per cent. of the 1-3-2 mixture.

It is therefore apparent that the proportions specified produced a concrete structurally weaker than other mixtures which might have been put in for less money.

My own practice has followed the views set forth by Prof. Baker. When I have been asked to suggest the constituent parts of a mixture to produce certain given results, I have used from 1-1-2 for the surface of artificial stone sidewalks, where density and resistance to wear is required; and 1-2-4 for the actual arch of concrete arch bridges, to a mixture of 1-6-12, which I used on one occasion to cover the bottom of a "Shoot the Shoots" pond in order to do away with trouble that had developed there from the stirring up of the mud at the bottom of the pond. In this connection I would say that an 8-inch cube of 1-4-8 concrete, taken direct from the mixing board during the construction of the foundation of an abutment at Middletown, built by the company of which I am Secretary (the sample procured by Mr. E. D. Graves, engineer of the work, and tested by Messrs. Lathburry & Spackman of Philadelphia), broke at 1032 lbs. per square inch, one year after mixing, the individual pieces of trap in the sample breaking in practically a straight line across the test piece, and not pulling out of the mortar at all. Regarding this test, however, the great difficulty of filling such a small cube with a concrete that is absolutely representative of the mass must not be lost sight of.

The important question as to the actual content of a barrel of Portland cement, is one that appears to be open to discussion. The Atlas Portland Cement Company in their pamphlet state regarding this, "figures are seldom quoted on account of difficulty of obtaining them under equal conditions of packing."

Mr. E. D. Graves gives me the following as the result of measurements made in 1898 of barrels in which Portland cement had been packed:

Alpha Domestic cement (barrels)	3.59 cu. ft.
Champion " " "	3.40 "
Alsen Imported " "	3.38 "
" " " (cylinders)	3.24 "

In 1899 Mr. Henry Souther, in making some tests for us, established the weight of a cubic foot of Atlas Portland cement loose at 91.27 lbs., making a barrel (380 lbs.) equal 4.16 cubic feet.

Major Walter L. Fisk, Corps of Engineers, U. S. A., in his report to the Chief of Engineers on Defenses of Mouth of Columbia River for 1899, states the cost of cement on his work at $2.68 per barrel. He then follows that in making a cubic yard of concrete he used three cubic feet of cement at a cost of $2.01, or just three-quarters of $2.68, demonstrating that he considered the content of a barrel of Portland cement, for the purpose of concrete, to be four cubic feet. (Report of Chief of Engineers for 1899, on Seacoast Defenses, page 1001.)

The volume of a barrel of Portland cement is established by the Aurora, Elgin & Chicago Railway, a first-class, cross-country electric railroad in Illinois, which has used concrete construction extensively, by the following clause in its specification:

"The proportions above expressed are units of volume, a quarter-barrel sack of Portland cement as packed by the manufacturer being accepted as a cubic foot. The sand must be measured loosely." (*Engineering News,* October 9, 1902.)

Going on to the question of the volumes of mortar, I find the following report by Mr. Henry Souther as the result of experiments made for us in 1899, being part of the same series of tests that has already been referred to. These tests were made for the purpose of verifying the results of a contract in which our return was governed by the amount of stone a 1–2 mortar would flush. We therefore only experimented with mortar so proportioned, and Mr. Souther found that one barrel of cement (taken at 4 cu. ft.) plus 8 cu. ft. of sand and mixed with sixteen gallons of water, made 8.35 cu. ft. of mortar. Mr. Souther then proceeded to experiment as to how much broken stone the 1–2 mortar would flush, having established beforehand that the stone he experimented with contained voids of 45.05 per cent. With this percentage of voids it is apparent that 8.35 cu. ft. of mortar would flush theoretically 18.53 cu. ft. of broken stone. The following is an extract from Mr. Souther's report of October 13, 1899:

"A practical determination of the amount of stone that 1–2 mortar will flush was made as follows: Six boxes, each 6 ft.

by 6 ft., were made, and were filled with three different mixtures of concrete, made in duplicate as follows. These were rammed in the boxes as nearly level as possible and the volume of concrete measured by taking 12 points along the edge and 4 through the center, the depth being taken as the average.

Sample No 1, mixed September 26th, 1899, at 4 P. M.—One barrel of Atlas cement, 8 cu. ft. of sand and 16 cu. ft. of stone, mixed with 16 gallons of water, after ramming gave a depth in box of .46 of a foot, or a volume of 16.58 cu. ft.

Sample No. 2, mixed September 27th, 1899, at 8.30 A. M.—Same mixture as No. 1, gave depth of .48 of a foot, or a volume of 17.14 cu. ft.

Sample No. 3, mixed September 27th, 1899, at 9.30 A. M.—One barrel of Atlas cement, 8 cu. ft. of sand and 24 cu. ft. of stone, mixed with 16 gallons of water gave a depth in box of .67 of a foot, or a volume of 24.2 cu. ft.

Sample No. 4, mixed September 27th, 1899, at 11 A. M.—Same mixture as No. 3, gave a depth in box of .68 of a foot, or a volume of 24.5 cubic feet.

Sample No. 5, mixed September 27th, 1899, at 2 P. M.—One barrel of Atlas cement, 8 cu. ft. of sand and 21.5 cu. ft. of stone, mixed with 16 gallons of water gave .60 of a foot depth in box, or a volume of 21.6 cu. ft.

Sample No. 6, mixed September 27th, 1899, at 3.30 P. M.—Same mixture as No. 5, gave a depth in box of .62 of a foot, or a volume of 22.3 cu. ft.

One of each of these samples of concrete, namely, No. 2, No. 3 and No. 4, were broken by pressure applied at the end of the lever (of which I understand you have photographs), yesterday afternoon, and the broken sections show in each case that the mass of concrete is thoroughly homogeneous and that all the voids are filled.

It is my opinion that the concrete in these samples was mixed a little drier than should have been, and had, say, 20 gallons of water been used, the resulting concrete would have been even better than it is."

I attach copies of the photographs referred to. Fig. 4 also shows the apparatus used in breaking the samples.

The above results show that the volume of concrete increased over the broken stone used in it, from practically no increase

No 2

No 3

in Samples 3 and 5, to an increase of 7 per cent. in Sample No. 2. In this line the following results from reports of officers of the United States Engineer Corps may be interesting.

Major Fisk states in the report before referred to, that it required 24 cu. ft. of crushed rock, 11 cu. ft. of sand and 3 cu. ft. of cement to make 1 cu. yd. of concrete. This gives an increase of bulk of concrete over stone used of 12½ per cent.

Major Henry M. Adams reports on work at northern side of eastern entrance of New York harbor, that it required as the mean of 4360 cu. yds. of concrete, 0.90 cu. yds. of stone, 0.45 cu. yds. of sand and 1.10 barrels of cement to make a cubic yard of concrete.

He then produced the same result at the southern side of the eastern entrance, where 8736 cu. yds. of concrete were placed, except that his cement was increased to 1⅓ barrels per cubic yard, and again at defenses of Staten Island, where in 5873 yards of concrete, he averaged 0.90 cu. yds. stone, 0.40 cu. yds. of sand, and 1.125 barrels of cement to the cubic yard (Report of Chief of Engineers on Seacoast Defenses for 1899, pages 763 ,766 and 774) ; Major Adams therefore found the increase of concrete over stone to have been $11^1/_{10}$ per cent. on the work he reported on.

Your Committee on Masonry in their report to the annual meeting of 1902, stated as follows: "We have recently run across a specification for concrete foundation work to be done in Virginia; in which the engineer has specified exactly the number of cubic feet of both sand and stone required per barrel, instead of giving the ratios only, as is usual. This is evidently done in order to avoid all possible diversity of opinion regarding the dimension of the basing unit, and we would gladly have the expression of the members as to their opinion regarding this course." The clause quoted was, if I remember correctly, embodied in this report at my suggestion, as the desirability of raising the question of doing away with all possible ambiguity in specifications for concrete had been forcibly brought to my attention, for the reason that I have just been called upon to examine two specifications for concrete work that varied greatly in this respect.

One of these specifications was for some very important work in New York State, and in it the mixture for the preponderating portion of the work was stated as follows, the proportions for the other parts only varying in the amounts of the aggregate to be used:

"Concrete for massive construction, such as retaining walls, column foundations and inverts (where such are used) will usually be proportioned: One part by volume of Portland cement. Eight parts of volume of aggregate of stone, gravel and sand," and again,

"The proportion of stone, gravel and sand will be varied from time to time by the engineer as he may require, in order to secure an 'aggregate' as nearly as possible free from voids, taking into account the sizes and qualities of the materials furnished." (Specification for Atlantic Avenue Improvement, Brooklyn, pars. 105 and 108.)

In this specification there is nothing whatever to show what the engineer intended to use as his basing unit. As before stated, Mr. Graves has measured barrels as small as 3.24 cu. ft. and Mr. Souther has placed the loose volume of a barrel of cement at 4.16 cu. ft. The comparative cost of the ingredients only, in one cubic yard of concrete, at the price in force when the work was let, and with voids of 45 per cent. in the broken stone used, will then be as follows:

Basing Unit, 3.24 cu. ft.	
Cost per cubic yard without labor................	$4.39
Basing Unit, 4.16 cu. ft.	
Cost per cubic yard without labor................	3.92

This shows a possible extreme divergence of opinion equal to $0.47 per cubic yard, which is surely worth considering, as the concrete covered by the specification amounted to approximately 90,000 cu. yds.

The other specification was the Virginia work before referred to. I am sorry to say I have not a copy of their specification at hand to quote from; but it stated squarely just how many cubic feet of sand and broken stone should be used to each barrel of cement in, if I recollect correctly, three different classes of concrete.

By reference to the Aurora, Elgin & Chicago specification before quoted, it will be seen that they reach the same result by defining the volume of a sack of Portland cement.

Mr. Allen Hazen, Assoc. M. Am. Soc. C. E., states as follows in a paper on the Theory of Concrete, published in the Proceedings of the American Society, volume 25, No. 6, page 448: "The most accurate and convenient method of determining the voids, known to the writer, is to determine, first, the specific gravity of the material as a whole, including the voids. The percentage of space occupied by the particles is then obtained by dividing the specific gravity of the mass as a whole, including the voids, by the specific gravity of the solid particles, and the voids are represented by the difference between the whole volume and the space occupied by the solid particles.

In case the material used for this purpose is not absolutely free from water, the whole or part of it must be dried after the experiment to determine the amount of water in it, and a correction applied therefor.

It will not do to dry a moist material before taking its specific gravity, as the closeness of the packing will be very likely to be different for wet and dry materials.

It is usually a comparatively easy matter to determine the specific gravity of the solid particles, but for large classes of materials the specific gravities are so uniform that the errors introduced by assuming an average value of 2.65 are very slight. The specific gravities of sand and gravels of the glacial drift of the Eastern States and of all silicious sands are very close to this figure, and much of the broken stone used for concrete is of nearly the same density. The proportion of voids is thus a direct function of the weight per cubic foot."

Mr. Hazen's manner of determining the voids in sand and broken stone was new to me; and it appeared to be reasonable and simple, I thought it might be well to verify his assumption that 2.65 is a safe figure at which to place the specific gravity of both the stone and the solid portions of sand as found in the Eastern States.

I therefore sent Mr. Souther two samples of sand from Burnside, Conn., which is fairly representative of the East Hartford sand used almost exclusively in Hartford. One of these samples, marked damp sand, was an average specimen of the sand as it comes from the bank and is ordinarily used in concrete. The other specimen, marked dry sand, had been artificially dried for use in the sprinklers of the cars of the Hartford Street Railway Company. The stone was trap rock from the quarry of The Hartford Trap Rock & Supply Company, at Newington Mountain. I append Mr. Souther's report as a whole.

"I have to report as follows upon the examination of the Hartford trap rock and sand submitted by you yesterday afternoon.

Sample 6332, marked Trap Rock.—Three pieces of this material broken from the large piece brought here by you, were weighed in air and in water and the specific gravity found with following results:

	Weight in Air.	Weight in Water.	Volume.	Specific Gravit
No. 1.......	670.9 gr.	446.7 gr.	224.2 cc.	2.993
No. 2.......	653.3 gr.	433.8 gr.	219.5 cc.	2.984
No. 3.......	299.8 gr.	198.9 gr.	100.9 cc.	2.974
		Average		2.984

Figuring on this basis, with water at 62.36 lbs. per cubic foot, we have the weight per cubic foot of this trap rock 186.1 lbs.

Sample 6333, marked Dry Sand, Burnside.—A clean glass bottle was weighed empty giving a weight of 55.3 gr. The dry sand was then poured in a slow stream into the bottle until filled completely and heaped up a little. The bottle was hit lightly with a pencil two or three times to settle it some, and then the top struck off flat.

Weight of bottle and dry sand, 803.6 gr.; weight of bottle, 55.3 gr.; weight of dry sand, 748.3 gr. The volume of the bottle was found to be 506.9 cc., making the apparent specific gravity of the sand as it exists in the bottle 748.3, dividing by 506.9 equals 1.48, the apparent specific gravity. Figuring on the same basis as above this gives 92.3 lbs. per cubic foot.

Water was then carefully added to the bottle of sand and finally the remaining parts of water were exhausted in a vacuum, and the weight of the bottle plus the dry sand plus the water to fill voids was found to be 995.2 gr. Subtracting from this bottle plus the dry sand 803.6 cc., gives the void filled 191.6 cc. of water. Then the volume of the sand is obtained by subtracting 191.6 cc. from the volume of the bottle, 506.9 cc., which leaves an actual volume of the sand particles 315.3 cc. Now dividing the weight of the sand, 748.3 gr. by this volume, 315.3 cc., gives 2.37 for the real specific gravity of the sand particles, or 147.8 lbs. per cubic foot as the weight. Voids, 37.6 per cent.

The moist sand was examined in exactly the same way. Owing to the moisture the sand did not flow as readily into the bottle as the dry sand did, but tended to go in lumps, but filling was obtained as near as possible as in the first case. The moist sand plus the weight of the bottle weighed 628.7 gr., subtracting the weight of the bottle, 55.3 gr., gave 573.4 gr. of sand; but the volume is 506.9, therefore the apparent specific gravity equals 573.4, divided by 506.9 or 1.13, giving a weight per cubic foot of 70.47 lbs.

The bottle was then filled with water to fill the voids. The weight was found to be 895 gr. Subtracting the weight of the bottle of sand, 628.7, we find 266.3 cc. of water used in filling the voids. The complete volume of the bottle is 506.9 cc.; subtracting the volume of water to fill the voids, 266.3 cc., leaves the volume of the sand proper 240.6 cc. Dividing the weight of the sand, 573.4 gr., by the volume 240.6 cc. we obtain the real specific gravity of the particles of sand to be 2.38, giving a weight per cubic foot of actual sand particles 148.5 lbs. Voids 52½%. This agrees very closely with the corresponding figure for the dry sand."

Noting the statement in the report that the "damp sand did not flow readily into the bottle," I, myself, tested some of the same sand, using a metal bucket and a common scale, and arrived at the folowing results:

Weight of sand as a whole	76 lbs. per cubic foot
Weight of solids in sand	148.97 lbs. per cubic foot
Voids in sand	49 per cent.

I append tabulation of the results:

	Stone.		Solids in sand.		Per cent. voids
	Sp. Gr.	Wt. Cu. Ft.	Sp. Gr.	Wt. Cu. Ft.	in sand.
Mr. Hazen	2.65	165.25	2.65	165.25	not given
Mr. Souther, dry sand	2.984	186.1	2.37	147.8	37.6
Mr. Souther, damp sand			2.38	148.5	52.5
My own experiment				148.97	49.0

From this it will be seen that the solids in the sand used here are considerably lighter and the stone considerably heavier than the weights given in Mr. Hazen's article, as a specific gravity 2.65 would produce a weight of 165.25 lbs. per cubic foot both for the solids in the sand and for the stone.

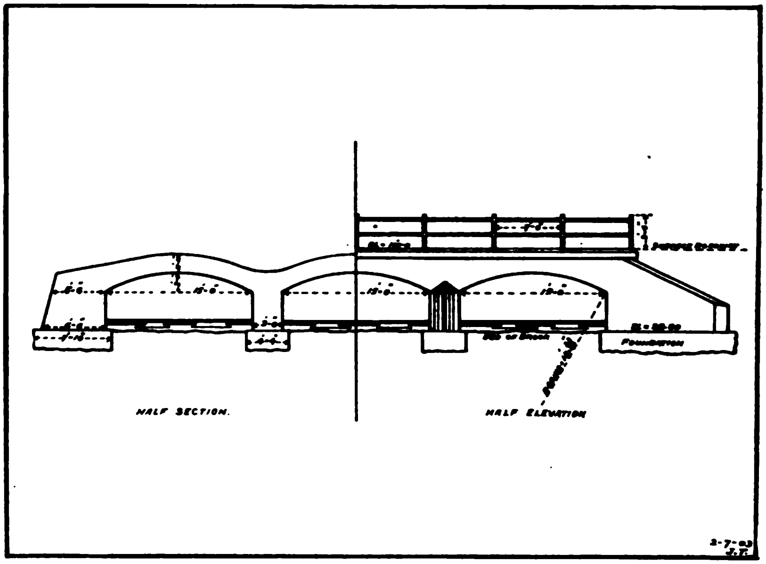
I beg to attach a section and elevation of a concrete arch bridge built by our Company at Scarrett's Mill, West Hartford, in October, 1901. These arches happen to embody the smallest relation of rise (2′) to span (15′) of any concrete arch, built without metal, with which I have been connected. I also enclose copy of a photograph of the same arch taken February 3, 1903. This work was proportioned as follows: The actual arches 8 cu. ft. of sand, and 16 cu. ft. of stone to each barrel of Portland cement. All other parts of the structure 12 cu. ft. of sand and 24 cu. ft. of stone to each barrel of Portland cement.

The preparation of these remarks has brought the following facts to my attention:

First, it is desirable to fill the voids in the broken stone to be used with just as good a mortar as the nature of the work and your available "pile" will warrant, but it is not desirable to use an amount of mortar very much in excess of said voids.

This excess is limited in the 1901 specification for concrete on the Middle Division of the New York State canals, to from one to two per cent.

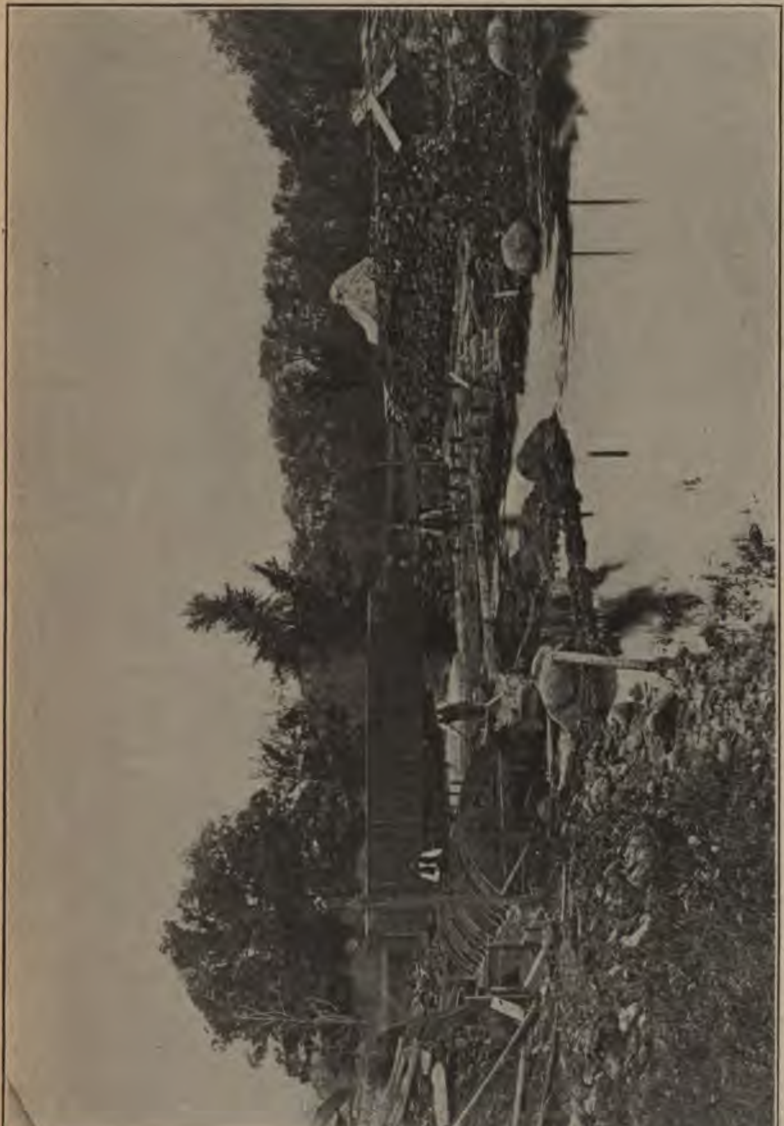
Second, avoid ambiguity in specifications by stating clearly either the number of cubic feet of both sand and broken stone to be used to each barrel of cement, or, the volume at which it is proposed to place the barrel of cement in proportioning your mixtures.

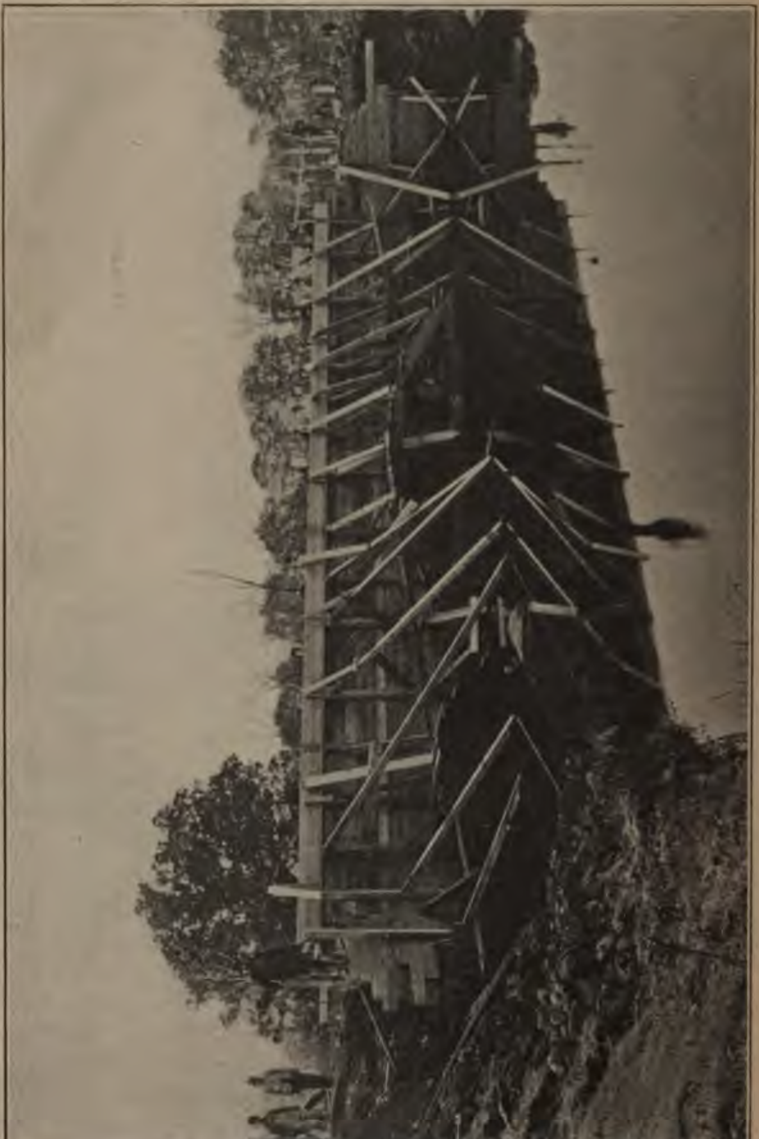


The variation of the meaning of the "aggregate," as used by different engineers quoted in this paper, will also probably bring itself to your attention.

The President: You have all heard Mr. Crawford's very interesting paper and I hope you will take some time in discussing it. During the past year I have put down about 6,000 yards of concrete myself, and I have been surprised how closely the use of the mixture 1–3–6 tallies with Mr. Crawford's statement. I found that the mixture 1–3–6 with a barrel of cement would make 24.4 cubic feet.

Mr. Verrill: Mr. President, I have here a few figures from two batteries which I built at Fisher's Island. In the case of





the larger battery the total aggregate yardage was 22,496, and in the case of the smaller one 7,018, comprising four different classes of concrete, as follows:

	Large Battery. Cu. Yds.	Small Battery. Cu. Yds.
Rosendale, 1-2-4	18,719	5,290
Portland, 1-2-4	194	156
Portland, 1-3-6	2,926	1,284
Portland granolithic, and wall finish.	657	288
Total	22,496	7,018
Deduct for large stone ("grout") in portions of work	2,690	497
Total net concrete	19,806	6,521

Taking the net concrete as a whole it required the following quantities of sand and broken stone to make one cubic yard of concrete:

	Large Battery. Cu. Yds.	Small Battery. Cu. Yds.
Sand	0.462	0.383
Broken stone	0.918	0.925

For the 1-2-4 Rosedale it required 1.414 bbl. of cement in the large battery and 1.396 bbl. in the small battery to make one cubic yard of concrete, the difference being due to the fact that in the latter case a large part of the cement was measured loose and in the former case it was in the original package. The difference in the proportions of sand and stone in the two batteries is due to decreasing the regular amount of sand called for in the small battery to allow for the dust and fine stone which a large part of the broken stone used in that battery contained.

MR. CRAWFORD: Of course these computations have been made up. I do not know why they do not give them in the magazines, but I have not found them in the reports.

THE PRESIDENT: I think that some other of the members have something they can tell us about concrete, some of their own personal experiences. I think that Major Powell might tell us something. He has used a great deal of it.

MAJOR C. F. POWELL: Mr. President and Gentlemen, I have observed one or two things about concrete, but before relating such observations I would like to express a wish that Mr. Crawford's paper may be printed.

MR. KELLOGG: It will be. The papers are always printed with the Proceedings.

MAJOR POWELL: I am glad to hear it. There is too much in that for me to digest off hand, and I thought at the time he read it I would like to have it for reference.

The gentleman who preceded me spoke about the reports of the chief engineer containing references to concrete, and to these computations. There are a good many valuable observations scattered through the report, but for the last two years these matters of engineering observations have been gathered together in a volume by itself known as the supplement. The last supplement to the report of the chief engineer is out, and that can be obtained by anybody, either through their congressman, or by writing direct to the chief engineer. Undoubtedly any civil engineer can get a copy there. The report for the year 1902 is already published, and this engineering supplement for 1902 is taken up more with the different experiments and trials which have been conducted, upon how to make rooms in fortifications dry, and to prevent leakage by definite devices, and especially in the interior lining. The supplement to the engineering notes of 1901 has a great deal in about concrete.

When I was out in Oregon many years ago as resident engineer at the Cascades canal on the Columbia river we had great difficulty to get natural sand, and the suggestion was made that we take the fine particles from the crusher and use that as sand. The rock that we crushed there was a basalt, and there was a large proportion that was quite fine, running from dust up to larger sizes, and which contained some grains as large as coarse sand. That did not turn out as one might expect because it took a good quantity of crushed stone to produce the necessary sand, and to get the necessary sand from this source there would be a surplus of broken stone. However, just as a matter of experiment I had a number of briquettes made and tested in the machine to see what the strength of the fine material from the crusher would be in comparison with the natural sand. This was twenty years ago or more, and at that time most of the specifications provided that the sand should be coarse, sharp and clean. I always thought that that requirement that the sand should be coarse was not sufficient. While you want coarse sand, at the same time you also need a fine sand in order to fill the voids. Now in our experiment we at first got only as good results from the crushed sand as we did from the natural sand, but I think that was because we tried to sift out every fine particle. The result of that trial led me to think that it was a good mixture with this crushed fine material, and it would tend to reduce the voids to a minimum if care was taken to sift and weigh and try. We tried it and finally we got at a mixture which when made up with cement in briquettes would give a tensile strength from 20 to 30, and even 40 per cent. greater than with the best natural sand we could get. Now that leads to this further question, that of cheapening concrete, while at the same time retaining its quality. The Germans use a great deal more broken stone than we do, and they get good concrete too. It is not uncommon in Germany, I believe, to use as high as ten to twelve parts of broken stone in concrete of first-class quality. I noticed in St. Louis several years ago a mixture which they used there without any natural sand at all, it being used for sidewalks more particularly. Sand as dredged from the Mississippi river is not very good. There was a German engineer that thought he could take a fine material which is obtained there very cheaply, and all through the west, and which has a basis in crushed and rolled stone, he producing that material in just about the same way as we tried to do in a small way out in Oregon several years ago. If any of you have been in St. Louis you may have seen a great many sidewalks made out of this material which contains no natural sand at all. In making it up out there they tried to regulate the quantity of the different sizes so as to produce a minimum of voids, and thereby save on the expense of the cement. This material is used with very good success. It has been used at the aqueduct of the water works at the Point of Rocks. The aqueduct is made entirely of it, but it does not go by the name of concrete, but is called granitoid. Since then it has been used to some extent in the cities of the middle West, particularly in Chicago and Cincinnati. When I was out on the Monongahela river I had to build there a half dozen concrete locks and dams, and I thought to encourage the contractor to regulate the size of the materials of his concrete, and thereby cheapen the cost of the work to him. I put in the specifications that the concrete should be of one measure by volume of cement and three of sand, and from five to eight parts of broken stone, or a mixture of broken stone with small gravel, in order that he could reduce the cost of his work. I thought the contractor would do better work, that he would get along nicer and that he would make more money out of it. The final measure was to remain with the engineer, that being a condition attached that the mortar should be of such a character that the particles of the stone and gravel would fill all the voids. Well, of course, at first the contractor supposed that it was proposed to use eight parts without any measure at all, but when he settled down upon the true reading of the specifications it was found to work very well. Then, as the specifications called for the use of very small gravel, that was also a help, and it was put in on purpose. There is a good deal of nice gravel in that country and a mixture of broken stone with a proportion of small, clean gravel was found to work very well. The gravel helped to fill up the voids, so that after the work had progressed a little while he found he was able to use 7, and even 7½, and that has been continued and has given very good results.

Now in our fortification work, where it is necessary to make very dense concrete, I had to prepare a table. I just picked up a manuscript copy last evening that I happened to have at my house in which the quantities of sand and of broken stone to be used with one part of cement, depending upon the volume of voids in the sand and in the broken stone, are given, the mixture being conditioned upon a required fixed arbitrary that there shall .be an excess of 10 per cent. of cement over the voids of the sand for the mortar and an excess of 10 per cent. of the voids of the broken stone. Now, in this table, just to show what large quantities of sand and stone can be used I will pick out for 30 per cent. voids of the sand. For the broken stone with such a mixture, for one volume of sand add 3.03 volumes of sand to one volume of cement. For 40 per cent. of voids in the broken stone 7.1, whereas if you come down to some stone which carries 50 per cent. of voids we could only use 5.7. If we go right down to sand with 40 per cent. of voids, why, under this assumption the table shows that the sand in proportion by volume would only be 2.3, and the stone, if the stone is 50 per cent. of voids, and lots of broken stone put in is at least 50 per cent., it is only 4.3.

Then another table prepared for me was one assuming for first-class work, and surface work, that the excess should be 20 per cent. of voids in the sand, and the broken stone also 20 per cent. over the voids. Of course that would give a somewhat smaller volume in proportion to one volume of cement. But all this goes to show that you can make good concrete with more of the stone. My experience on the Monongahela river and on the Alleghany river goes to show that a mixture of fine gravel, where it can be readily obtained, when put with the broken stone makes pretty good concrete, and especially so for foundations where tensile strength is not particularly required. Doubtless for tensile strength broken stone alone is better than gravel concrete.

When at Pittsburg I had some experiments made, which may be of some interest, in the use of granulated slag instead of sand. It was about the time that the slag cements were coming on the market. They were made cheaper than the true Portland cement. I thought that the slag cement seemed to be of a little doubtful quality. I did not know about the permanency of the concrete. As there were immense quantities of this slag at the Pittsburg furnaces all going to waste, I went on with an experiment for obtaining the slag sand by granulating it with water, water baths, and afterwards in a stream of water, and in that way the slag as it came from the furnaces could be got ready, and as we thought in about the right proportion of different sizes and kinds of slag. I also used as a comparative experiment some of the best Alleghany river sand, which is very good; taking this under the same conditions and making briquettes first with the slag sand and then with the river sand, using the same cement, the same proportions, and by the same manipulation, so as to put out of the problem any other change than the change in the sand alone. Much to our surprise the slag sand gave a better briquette right straight through except immediately at first. It seemed after one or two days that the results ran about equal. At the end of a week the slag samples increased in strength; at the end of two weeks a little more. At the end of that time there came up a matter which occasioned me to drop the experiment altogether, and that was, the slag sand briquettes at that time commenced to show little defects: small swellings and fine cracks, so that at last in ten briquettes which we broke at three months, four of them were quite defective, even to the eye. That goes to show, when you come right down to it, that slag is not to be depended upon, notwithstanding that the average of the ten in the comparative tests still gave a higher tensile strength than the river sand samples.

Parts of Sand and Broken Stone or other Aggregate to be used with one Volume of Cement for Sand and Aggregate of Various Percentages of Voids,—the Cement being 10% in Excess of the Voids in the Sand and the Mortar being 10% in Excess of the Voids in the Aggregate.

Per cent. of voids in sand.	Volumes of sand for one volume of cement.	Volumes of aggregate for various percentages of voids in the same.					
		40%	42%	44%	46%	48%	50%
20	4.55	10.57	10.03	9.59	9.16	8.78	8.43
24	3.79	8.84	8.40	8.02	7.67	7.34	7.05
28	3.25	7.60	7.22	6.91	6.60	6.32	6.07
30	3.03	7.11	6.76	6.46	6.16	5.91	5.68
32	2.84	6.68	6.34	6.06	5.80	5.55	5.33
34	2.67	6.30	5.99	5.71	5.46	5.23	5.02
36	2.52	5.96	5.66	5.41	5.16	4.95	4.75
38	2.39	5.66	5.37	5.14	4.91	4.70	4.51
40	2.27	5.39	5.12	4.89	4.66	4.47	4.29

Parts of Sand and Broken Stone or other Aggregate to be used with one Volume of Cement for Sand and Aggregate of Various Percentages of Voids,—the Cement being 20% in Excess of the Voids in the Sand and the Mortar being 20% in Excess of the Voids in the Aggregate.

Per cent. of voids in sand.	Volumes of sand for one volume of cement.	Volumes of aggregate for various percentages of voids in the same.					
		40%	42%	44%	46%	48%	50%
20	4.17	9.03	8.60	8.22	7.85	7.53	7.22
24	3.48	7.59	7.21	6.89	6.58	6.32	6.06
28	2.98	6.55	6.24	5.95	5.68	5.46	5.24
30	2.78	6.14	5.85	5.58	5.33	5.12	4.91
32	2.61	5.77	5.50	5.25	5.02	4.81	4.61
34	2.45	5.46	5.20	4.96	4.73	4.55	4.36
36	2.32	5.17	4.92	4.70	4.49	4.31	4.14
38	2.20	4.92	4.68	4.48	4.27	4.10	3.94
40	2.08	4.69	4.46	4.27	4.07	3.91	3.75

MR. JOHNSON: There is one point I would like to ask Mr. Crawford about. As I understand him, in one of his statements he said that he used two different amounts of water. I would like to ask him what his experience is in regard to the amount of water—how much should be put in to get the proper consistency of the concrete?

MR. CRAWFORD: It is my opinion that the concrete when it is put in should be of about the consistency of good damp liver, so that you do not have to ram it very much. I do not think it gives so good a result when very wet. That is merely my opinion. Probably Major Powell can answer that better than I can because he has probably had more experience. But my personal opinion is that it should go in when of about the consistency of good damp liver so as to fill the voids.

MR. JOHNSON: I should like to hear what Major Powell's experience has been in this.

MAJOR POWELL: I think that the consensus of opinion is setting toward wet concrete, and I believe that one reason for that is the difficulty in ramming the concrete when it is dry. General Casey, who was the engineer at the Congressional Library in Washington, and who built the underpinning and foundation of the Washington monument, and completed the monument, had a great deal of experience, and at a time, too, when the engineers of the army were using concrete about the fortifications when it first came into use, and his rule was to make the concrete look like brown sugar. That would be a little dry. In experimenting with briquettes my own observation has been that different cements require different amounts of water in order to develop their highest tensile strength. In the experiments with slag sand, of which I have spoken before, we had to vary the quantities of water. I should have mentioned that at the time. We took the slag sand by itself and used different proportions of water in making up the briquettes until we found that proportion which seemed to give the highest tensile strength, and that, I think, was 13 per cent. of the volume. With the other,—and the cement by the way, was Atlas cement,—we found something like 9 or 10 per cent. of water gave the greatest tensile strength.

A MEMBER: May I ask what method you used in mixing the concrete, whether by machine or by hand? Which do you advocate?

MAJOR POWELL: I think by machine because it is so much cheaper; but I believe that hand mixture of concrete is very good when you have a good man to supervise the mixing so that you can get a good product. For large concrete constructions, however, you cannot get enough good men, and you cannot get the space. You cannot make a concrete fast enough. In my judgment the concrete mixer is the thing.

In talking about mixers, I would like to ask if any gentleman here has ever seen a mixer which is cylindrical in shape. I have heard of such a mixer. I heard that such a mixer was made and used some four or five years ago; and although I knew the manufacturers who made the machine from designs furnished by an engineer, I have never heard the manufacturers speak of that machine. I know about the cubical mixers, but I would like to know about the cylindrical mixer, and how it worked, whether it was good or not.

MR. CRAWFORD: There was one that I heard about that was in process of invention. I do not know whether the inventor ever had it patented. It was cylindrical. That is the nearest I ever saw to it. It seemed to embody some good ideas. When the concrete got to the place where you wanted to use it, it was mixed. Whether he patented it or not I do not know. This man, I think, lived in Portland, Me. He is probably in Portland yet.

THE PRESIDENT: Gentlemen, if there is no more discussion, this ends our annual meeting of 1903.

MR. KELLOGG: I do not know whether I am in order or not, Mr. President, but I would like to propose a vote of thanks to Professor Burton for his very entertaining lecture.

Motion seconded and passed by unanimous vote.

THE SECRETARY: I would like, also, Mr. President, to move a vote of thanks to the Hartford Street Railway Company for providing us with transportation and bringing us out to the Golf Club grounds.

Motion seconded and passed.

MR. KELLOGG: Mr. President, I would like to move a vote of thanks to Mr. Crawford. I think he is especially deserving of our thanks for the amount of time and labor he has expended in getting up these statistics. Most of us will appreciate this, I think, when we come to get our reports and read them.

Motion seconded and passed.

THE SECRETARY: I do not intend that Mr. Kellogg shall get ahead of me, and I should like to move a vote of thanks to the Committee of Arrangements, and to the Hartford Golf Club.

Motion seconded and passed.

Motion to adjourn seconded and passed, and the meeting declared to be adjourned by the President without date.

Among those present were: C. B. Vorce, Hartford; A. E. Burton, Boston; C. H. Bunce, Hartford; J. K. Punderford, New Haven; F. B. Marsh, *Engineering Record*, New York; S. E. Barney, New Haven; J. Frederick Jackson, New Haven; F. L. Ford, Hartford; Joseph Buths, Hartford; Roland D. Barnes, Bristol; Geo. H. Sage, Berlin; H. J. Kellogg, New Haven; E. D. Graves, Hartford; Henry Souther, Hartford; Frank A. Maloney, New Haven; Paul Nash, Stamford; J. C. Tracy, New Haven; O. B. Swain, Clinton; H. A. Weaver, Clinton; George E. Manning, New London; W. C. Johnson, Hartford; Chas. F. Powell, New London; Chas M. Crawford, Hartford; W. R. C. Corson, Hartford; Frank Caum, Hartford; E. W. Bush, Hartford; F. Irwin Davis, Hartford; Wm. D. Johnson, Hartford; T. A. Curtis, Hartford; S. B. Palmer, Norwich; E. P. Augur, Middletown; Geo. K. Crandall, New London; C. E. Chandler, Norwich; Wm. H. Cadwell, New Britain; Frank N. Hoyt, Hartford; H. B. Wightman, Norwich; J. Hill Brand, Norwich; F. R. Bartlett, Norwich; W. B. Palmer, Bridgeport; Frederick S. Wardwell, Stamford; H. A. Storrs, New London; Chas. N. Nichols, New Haven; Charles S. Farnham, Hartford; S. P. Waldron, East Berlin; E. W. Stearns, East Berlin; Edgar T. Belden, Middletown; John T. Henderson, Hartford; J. W. Phelps, Hartford; H. G. Clark, Hartford; R. N. Clark, Hartford; W. A. Brown, Springfield; C. E. Beach, West Hartford; A. B. Alderson, West Hartford; N. C. Spencer, Hartford; C. M. Gallup, Hartford; H. B. Snell, Hartford; Elijah H. Owen, Hartford; Max J. Unkelbach, New Britain; Henry R. Buck, Hartford; Ely M. T. Ryder, New Haven; Paul Sterling, Bridgeport; John P. Murphy, Hartford; E. M. Stone, Hartford; G. E. Verrill, New Haven; F. W. LaForge, New Haven; J. M. McKenzie, Wallingford.

List of Members.

With Addresses and Dates of Election.

Members are particularly requested to keep the Secretary constantly informed as to their correct addresses.

HONORARY MEMBERS.

PROF. RUSSELL H. CHITTENDEN Dean of Sheffield Scientific School of Yale University, New Haven, Conn.	April 20, 1901
EDGAR CLARK Putnam, Conn.	June, 1887
JOHN E. CLARK Prof. Mathematics, Emeritus, at Sheffield Scientific School, Yale University, South Terrace, Longmeadow, Mass.	April, 1884
DESMOND FITZGERALD Engineer Sudbury Division, Metropolitan Water Board, 1 Ashburton Place, Boston, Mass.	Jan. 8, 1901
GEORGE H. FROST President Engineering News Publishing Co., New York.	April, 1884
DR. ARTHUR T. HADLEY President Yale University, New Haven, Conn.	April 20, 1901
EDWARD C. HAYNES Centre Lebanon, Maine.	Jan. 14, 1890
BRADLEY H. HULL Bridgeport, Conn.	April, 1884
WILLIAM E. PETTEE Civil Engineer, Salisbury, Conn.	Jan. 10, 1899
FRANK W. SKINNER Editorial Staff of the Engineering Record, New York.	Jan. 9, 1900

ACTIVE MEMBERS.

ARTHUR A. ADAMS Superintendent of Streets, Springfield, Mass.	Jan. 9, 1900
JULIUS L. ADAMS Civil Engineer Hartford, Manchester and Rockville Tramway Co., South Manchester, Conn.	July 18, 1899
ALGERNON B. ALDERSON Town Engineer, West Hartford, Conn.	Jan. 10, 1899
WALTER H. ALLEN Engineering Department, N. Y., N. H. & H. R. R. Co., New Haven, Conn.	Feb. 11, 1902
ROSWELL ATKINS Civil Engineer and Surveyor, Bristol, Conn.	Jan. 12, 1897

EDWIN P. AUGUR ....April, 1884
Civil Engineer and Surveyor, Middletown, Conn.

HENRY W. AYRES ....Jan. 13, 1885
Hydraulic Engineer, Hartford, Conn.

JOHN W. BACON ....Jan., 1884
Civil Engineer, Danbury, Conn.

SAMUEL E. BARNEY ....Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School, Yale University,
New Haven, Conn.

CHARLES EDWARD BEACH ....Jan. 10, 1893
Civil Engineer, West Hartford, Conn.

EDGAR T. BELDEN ....Jan. 8, 1901
Middletown, Conn.

CLIFFORD H. BELDEN ....March 30, 1900
Civil Engineer, Hartford, Conn.

RAYMOND F. BENNETT ....March 30, 1900
W. F. Bennett & Son, Contractors, Portland, Maine.

RICHARD M. BERRIAN ....Jan. 9, 1900
Engineering Department, N. Y., N. H. & H. R. R. Co.,
Bridgeport, Conn.

GEORGE H. BISHOP ....Jan. 13, 1885
Hydraulic Engineer, Middletown, Conn.

CLARENCE BLAKESLEE ....Jan. 9, 1900
Civil Engineer and Contractor, New Haven, Conn.

GEORGE L. BLAKESLEE ....Jan. 8, 1901
Engineer Federal Sugar Refining Co., 138 Front St., N. Y.

JAMES P. BOGART ....Jan. 9, 1900
Civil Engineer, New Haven, Conn.

DANIEL E. BRADLEY ....Jan. 9, 1894
President Berlin Construction Co., Berlin, Conn.

DANIEL E. BRINSMADE ....April 20, 1901
Secretary and Assistant Engineer Ousatonic Water Co., Shelton, Conn.

D. S. BRINSMADE ....April, 1884
Engineer Housatonic Water Power Co., Derby, Conn.

CHARLES O. BROWN ....Jan. 11, 1898
Civil Engineer and Surveyor, Danbury, Conn.

WALTER A. BROWN ....Oct. 11, 1902
Assistant City Engineer, Springfield, Mass.

EDMUND BROWN ....Jan. 10, 1899
Superintendent and Engineer of Norfolk Water Co., Norfolk, Conn.

HENRY R. BUCK ....Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

JOHN E. BUDDINGTON ....March 30, 1900
Consulting Engineer and Contractor, New Haven, Conn.

CHARLES H. BUNCE ....April, 1884
Civil Engineer, Hartford, Conn.

LUTHER W. BURT ....Jan. 13, 1885
Civil Engineer and Surveyor, Hartford, Conn.

LUTHER HAROLD BURT ....Aug. 14, 1900
Department of Engineering, Maintenance of Way, Penn. R. R.,
Philadelphia, Pa.

EDWARD W. BUSH ....Jan. 10, 1899
Assistant Engineer Conn. River Bridge and Highway District,
Hartford, Conn.

EMIL CHARLES BUSCHOR .... Jan. 10, 1899
Civil Engineer and Surveyor, Central Valley, New York.

WILLIAM H. CADWELL .... May 31, 1893
Civil Engineer, New Britain, Conn.

ALEXANDER CAHN .... Jan. 9, 1900
Civil Engineer, New Haven, Conn.

ROBERT A. CAIRNS .... Aug. 29, 1890
Sanitary and Hydraulic Engineer and City Engineer. Waterbury, Conn.

HUBER D. CARD .... Oct. 24, 1895
Civil Engineer and Surveyor, Willimantic, Conn.

HARRY E. CARLISLE .... Jan. 9, 1900
Engineer S. N. E. Telephone Co., New Haven, Conn.

RALPH B. CARTER .... Jan. 14, 1890
Civil Engineer, 26 Courtlandt St., New York.

FRANK CAUM .... Aug. 14, 1900
Superintendent Hartford Street Railway, Hartford, Conn.

FREDERICK S. CHAPMAN .... Feb. 10, 1903
Philippine Islands.

CHARLES F. CHASE .... March 30, 1900
Engineer Berlin Construction Co., New Britain, Conn.

CHARLES E. CHANDLER .... April, 1884
Civil Engineer, Norwich, Conn.

RICHARD OTIS CHENEY, JR. .... Jan. 9, 1900
Civil Engineer, South Manchester, Conn.

HERBERT G. CLARK .... July 18, 1899
Engineer of Keney Park, Hartford, Conn.

ROSCOE N. CLARK .... July 18, 1899
Civil Engineer Department of Public Parks, Hartford, Conn.

WILLIAM S. CLARK .... Jan. 14, 1890
City Engineer, Meriden, Conn.

WILLIAM B. COCHRANE .... Jan. 14, 1890
Civil Engineer, Stamford, Conn.

THEODORE I. COE .... Jan. 9, 1900
Superintendent of Construction, 454 Fifth Ave., New York.

R. C. P. COGGESHALL .... June, 1887
Superintendent of Water Works, New Bedford, Mass.

HARRY C. COLLINS .... July 18, 1899
Berlin Construction Co., Boston, Mass.

WILLIAM R. C. CORSON .... Feb. 10, 1903
Civil Engineer, Hartford, Conn.

GEORGE K. CRANDALL .... Jan. 11, 1887
City Engineer, New London, Conn.

CHARLES M. CRAWFORD .... July 18, 1899
Secretary Hartford Paving and Construction Co., Hartford, Conn.

NORMAN McDONALD CRAWFORD .... July 18, 1899
General Manager Hartford Street Railway Co., Hartford, Conn.

FAYETTE S. CURTIS .... Jan. 9, 1900
Vice President N. Y., N. H. & H. R. R. Boston, Mass.

THEODORE ALLEN CURTIS .... Aug. 14, 1900
Curtis & Johnson, Hartford, Conn.

LOREN E. DABOLL .... Jan. 8, 1895
Civil Engineer, New London, Conn.

COURTLAND R. DARROW .... Jan. 8, 1895
With William G. Smith, Waterbury, Conn.

ARTHUR L. DAVIS .... July 18, 1899
Assistant Manager Eastern District and Export, American Bridge Co.,
100 Broadway, New York.

F. IRWIN DAVIS .... Oct. 11, 1902
Architect, Hartford, Conn.

FREDERICK DePEYSTER .... Sept. 3, 1891
Byxbee-DePeyster Trap Rock Co., Meriden, Conn.

SOLOMON LeF. DEYO .... Jan. 9, 1900
Chief Engineer New York Rapid Transit Subway Construction Co.,
New York City, N. Y.

AUGUSTUS J. DuBOIS .... Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School, Yale University,
New Haven, Conn.

FREDERICK J. EASTERBROOK .... March 30, 1900
Assistant Engineer N. Y., N. H. & H. R. R. Co., Bridgeport, Conn.

MALCOLM E. ECKHART .... Feb. 11, 1902
Derby Gas Works, Derby, Conn.

CHARLES W. EDDY .... Jan. 9, 1900
Assistant Engineer Wigwam Reservoir, Thomaston, Conn.

FREDERICK H. ELLSWORTH .... March 30, 1900
Division Engineer N. Y., N. H. & H. R. R. Co., New Haven, Conn.

EDW. H. EVERITT .... Oct. 11, 1902
S. N. E. Telephone Co., New Haven, Conn.

CHARLES H. EWING .... Jan. 9, 1900
Reading R. R., Pa.

CHARLES A. FERRY .... Jan. 9, 1900
Civil Engineer and Surveyor, New Haven, Conn.

HENRY DeB. FORBES .... April 20, 1901
Engineer H. E. Talbot, Dayton, Ohio.

FREDERICK L. FORD .... Jan. 12, 1897
City Engineer, Hartford, Conn.

THEODORE B. FORD .... April 20, 1901
Civil Engineer, Bridgeport, Conn.

AUBREY D. FULLER .... Feb. 10, 1903
Civil Engineer, New Haven, Conn.

WILL H. FULTON .... Jan. 8, 1901
City Engineer's Office, New Haven, Conn.

EDWARD GAGEL .... Jan. 9, 1900
Division Engineer N. Y., N. H. & H. R. R. Co., West Haven, Conn.

CHRISTOPHER M. GALLUP .... Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

GEORGE W. F. GILLETTE .... Jan. 9, 1900
G. M. Grant Co., New Haven, Conn.

HENRY H. GLADDING .... Jan. 9, 1900
Assistant City Engineer, New Haven, Conn.

EDWARD O. GOSS .... Nov. 29, 1890
Assistant Treasurer Scovil Mfg. Co., Waterbury, Conn.

EDWIN D. GRAVES .... Oct. 25, 1895
Chief Engineer Conn. River Bridge and Highway District,
Hartford, Conn.

PERCY T. W. HALE .... Feb. 10, 1903
Civil Engineer, Portland, Conn.

A. CLARK HALL .... Jan. 8, 1901
Hartford Water Department, West Hartford, Conn.

MORRISON C. HAMILTON .... Jan. 9, 1900
With N. Y., N. H. & H. R. R. Co., Hartford, Conn.

F. B. HASTINGS, Associate Member .... Feb. 10, 1903
B. D. Peirce Co., Bridgeport, Conn.

BENJAMIN F. HATHAWAY .... Aug. 14, 1900
Stamford, Conn.

ARTHUR S. HAWLEY .... Feb. 11, 1902
C. W. Blakeslee & Co., Fall River, Mass.

LOUIS R. HAZELTINE .... Feb. 11, 1902
Architect, 94 State St., New London, Conn.

ADRIAN C. HEITMAN, JR. .... Feb. 10, 1903
Civil Engineer, West Haven, Conn.

N. F. HEFT .... Jan. 8, 1901
Supt. Electrical Department N. Y., N. H. & H. R. R.,
Bridgeport, Conn.

JOHN T. HENDERSON .... July 18, 1899
Draftsman Conn. River Bridge and Highway District, Hartford, Conn.

ALBERT B. HILL .... Jan. 9, 1900
Civil and Consulting Engineer, New Haven, Conn.

FRANK E. HINE .... April 20, 1901
Fisher's Island, N. Y.

FRANK N. HOYT .... July 18, 1899
Civil Engineer Highway Commissioner's Office, Hartford, Conn.

C. M. INGERSOLL, JR. .... Jan. 8, 1901
Chief Engineer N. Y., N. H. & H. R. R., New Haven, Conn.

J. FREDERICK JACKSON .... Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

CHARLES M. JARVIS .... April, 1884
Vice President P. & F. Corbin, New Britain, Conn.

FRANK B. JAYNES .... Feb. 10, 1903
Civil Engineer, Bridgeport, Conn.

WILLIAM D. JOHNSON .... Aug. 14, 1900
Architect, 926 Main St., Hartford, Conn.

WILLIAM E. JOHNSON .... Nov. 29, 1890
Engineer of Hartford Water Works, West Hartford, Conn.

WALTER A. JONES .... Feb. 10, 1903
Civil Engineer, New Haven, Conn.

HERBERT C. KEITH .... Jan. 9, 1900
Mason City & Fort Dodge R. R., Fort Dodge, Iowa.

HENRY J. KELLOGG .... April, 1884
First Assistant City Engineer, New Haven, Conn.

CASSIUS W. KELLY .... Jan. 9, 1900
City Engineer, New Haven, Conn.

RICHARD S. KIRBY .... March 30, 1900
Civil Engineer, Port Chester, N. Y.

HERBERT M. KNIGHT .... Jan. 9, 1900
Constructing Engineer of the Continental Compressed Air Co.,
Norwich, Conn.

FRANK H. KITCHEN .... Jan. 8, 1901
With Hartford Street Railway Co., Hartford, Conn.

FREDERICK W. LAFORGE .... Jan. 13, 1885
U. S. Engineer, New Haven, Conn.

JOHN S. LANE .... Jan. 8, 1901
John S. Lane & Sons, Meriden, Conn.

E. LeROY LANE .... Jan. 8, 1901
Contractor, Hingham, Mass.

EDWIN F. LAWTON .... March 30, 1900
Superintendent Hartford Electric Light Co., Hartford, Conn.

SMITH S. LEACH .... Jan. 8, 1901
Major Engineers, U. S. Government, Fort Leavenworth, Kansas.

EDWIN M. LEE .... Feb. 10, 1903
Civil Engineer, New Haven, Conn.

ROBERT P. LEWIS .... Oct. 24, 1895
Secretary Blake & Johnson, Waterbury, Conn.

FRANK W. LOOMIS .... July 18, 1899
Civil Engineer and Surveyor, Hartford, Conn.

ROBERT Q. MACMAHON .... Feb. 10, 1903
Civil Engineer, New London, Conn.

DENNIS J. MALONEY .... April 20, 1901
Superintendent of Buildings, Board of Education, New Haven, Conn.

FRANK A. MALONEY .... Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

GEORGE E. MANNING .... Jan. 11, 1898
Civil Engineer, New London, Conn.

THEODORE H. McKENZIE .... April, 1888
Sanitary and Hydraulic Engineer, Southington, Conn.

J. M. McKENZIE .... April, 1884
Civil Engineer and Surveyor, Yalesville, Conn.

JOHN T. McKNIGHT .... May 31, 1893
City Engineer, Rockville. Residence, Ellington, Conn.

CHARLES W. MERRELS .... Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

GEORGE S. MILLER .... Aug. 22, 1901
Civil Engineer U. S. Fortification, Fisher's Island, N. Y.

SHELDON E. MINER .... Sept. 25, 1886
Civil Engineer, Greenwich, Conn.

ROBERT E. MITCHELL .... Jan. 9, 1900
Civil Engineer and Surveyor, Willimantic, Conn.

WM. HARLEY MOORE .... Jan. 9, 1900
Engineer Bridges, N. Y., N. H. & H. R. R., New Haven, Conn.

ERNEST B. MOSS .... April 20, 1901
Civil Engineer, H. Wales Lines Co., Meriden, Conn.

JOHN P. MURPHY .... July 18, 1899
City Engineer's Office, Hartford, Conn.

PAUL NASH .... Jan. 9, 1900
Civil Engineer and Surveyor, Stamford, Conn.

EDWARD S. NETTLETON .... Jan. 9, 1900
Civil Engineer, New Haven, Conn.

CHARLES H. NICHOLS .... Jan. 8, 1901
Consulting Engineer and Engineer of Shell Fish Commission,
New Haven, Conn.

EDWARD J. NOBLE .... Jan. 8, 1901
Hartford, Conn.

FRANCIS H. OLDERSHAW .... Jan. 8, 1901
City Engineer, New Britain, Conn.

C. HENRY OLMSTED .... July 18, 1899
Civil Engineer and Surveyor, East Hartford, Conn.

FRED H. OSBORNE .... Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

ELIJAH H. OWEN .... March 30, 1900
Civil Engineer, Hartford, Conn.

SHEPARD B. PALMER .... Jan. 8, 1895
Civil Engineer and Surveyor, Norwich, Conn.

GEORGE E. PALMER .... March 30, 1900
Assistant Engineer N. Y., N. H. & H. R. R., West Haven, Conn.

WILLIAM B. PALMER .... Jan. 13, 1885
Civil Engineer and Surveyor, Bridgeport, Conn.

GEORGE A. PARKER .... July 18, 1899
Superintendent of Keney Park, Hartford, Conn.

FRED H. PARSONS .... Oct. 11, 1902
Engineering Department, N. Y., N. H. & H. R. R., Bridgeport, Conn.

HAROLD A. PARSONS .... Aug. 14, 1900
City Engineer, Stamford, Conn.

ARTHUR J. PATTON .... Sept. 12, 1889
Land Surveyor, Waterbury, Conn.

ERMON M. PECK .... Jan. 8, 1895
Assistant Engineer Hartford Water Works, West Hartford, Conn.

LEON F. PECK .... Oct. 11, 1902
Civil Engineer, Greenwich, Conn.

GEORGE W. PENFIELD .... Jan. 8, 1901
51 Center St., New Britain, Conn.

JAMES W. PHELPS .... Oct. 11, 1902
Civil Engineer, Hartford, Conn.

STEPHEN C. PIERSON .... Jan. 13, 1885
Civil Engineer and Surveyor, Meriden, Conn.

ROBERT G. PIKE .... Jan. 8, 1901
Street Commissioner, Middletown, Conn.

DANIEL C. POTTER .... Jan. 8, 1901
Civil Engineer, Fairhaven, Mass.

MAJOR CHARLES F. POWELL .... Feb. 10, 1903
U. S. Engineer, New London, Conn.

JOHN K. PUNDERFORD .... Jan. 9, 1900
Engineer Fair Haven and Westville R. R. Co., New Haven, Conn.

WM. B. REYNOLDS .... Aug. 14, 1900
Land Surveyor, Waterbury, Conn.

ARTHUR W. RICE .... April, 1884
President Union Mfg. Co., New Britain, Conn.

WALTER H. RICHARDS .... March 30, 1900
Engineer of Water and Sewer Departments, New London, Conn.

HALBERT G. ROBINSON .... Jan. 11, 1898
Civil Engineer and Survevor, Patten, Maine.

ROBERT W. ROLLINS .... Jan. 9, 1900
General Manager Hartford Electric Light Co., Hartford, Conn.

EDWARD J. RUNGEE .... Jan. 8, 1901
Civil Engineer, Greenwich, Conn.

ELY M. T. RYDER .... Jan. 9, 1900
Civil Engineer and Surveyor, New Haven, Conn.

GEORGE H. SAGE .... Jan. 8, 1895
Vice President Berlin Construction Co., Berlin, Conn.

JAMES F. SHAUGHNESSY .... Feb. 11, 1902
Board of Water Commission, Hartford, Conn.

H. HILLIARD SMITH .... March 30, 1900
Architect, Hartford, Conn.

WILLIAM G. SMITH .... April, 1884
Civil Engineer and Surveyor, Waterbury, Conn.

HARRY B. SNELL .... Jan. 8, 1901
With Hartford Street Railway Co., Hartford, Conn.

THOMAS C. B. SNELL .... July 18, 1899
Engineer Hartford Street Railway Co., Hartford, Conn.

HENRY SOUTHER .... Jan. 10, 1899
Consulting Engineer, Hartford, Conn.

NORMAN C. SPENCER .... Jan. 8, 1901
Assistant in City Engineer's Office, Hartford, Conn.

WALTER T. SPENCER .... Jan. 9, 1900
Division Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

A. WILLIAM SPERRY .... Jan. 9, 1900
Civil Engineer and Surveyor, New Haven, Conn.

ELMER W. STEARNS .... Oct. 11, 1902
Civil Engineer, Berlin, Conn.

EDGAR H. STILES .... Oct. 11, 1902
Superintendent Lathrop, Shea & Henwood Co., Bridgeport, Conn.

PAUL STIRLING .... Oct. 11, 1902
American Tube & Stamping Co., Bridgeport, Conn.

RAYMOND FRENCH STODDARD .... Jan. 9, 1900
Civil Engineer with N. Y., N. H. & H. R. R., Bridgeport, Conn.

EDWARD M. STONE .... July 18, 1899
With H. A. Wolcott, Hartford, Conn.

HARRY A. STORRS .... July 18, 1899
Geological Survey, Washington, D. C.

LUCIAN A. TAYLOR .... June, 1887
Civil Engineer and Contractor, Boston, Mass.

ALFRED H. TERRY .... Feb. 11, 1900
Engineering Department, N. Y., N. H. & H. R. R. Co.,
Bridgeport, Conn.

JAMES B. THOMAS .... Jan. 9, 1900
Civil Engineer and Surveyor, Hartford, Conn.

JOHN C. TRACY .... Jan. 9, 1900
Assistant Professor of Structural Engineering, Yale University,
New Haven, Conn.

WALTER E. TRUESDELL .... June 11, 1898
With Joseph H. Wallace, C.E., New York City.

MAX J. UNKELBACH .... Jan. 9, 1900
With W. H. Cadwell, New Britain, Conn.

GEORGE E. VERRILL .... Feb. 11, 1902
U. S. Assistant Engineer, New Haven, Conn.

CLARENCE B. VORCE .... Jan. 10, 1899
Civil and Consulting Engineer, Hartford, Conn.

A. R. WADSWORTH .... Oct. 27, 1886
Civil Engineer and Surveyor, Farmington, Conn.

EDWARD T. WARD .... Jan. 9, 1900
Consulting Engineer, Bridgeport, Conn.

ALBERT L. WASHBURN .... Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

HALSEY A. WEAVER .... Jan. 12, 1897
Civil Engineer, Clinton, Conn.

NELSON J. WELTON .... April, 1884
Civil and Hydraulic Engineer, Waterbury, Conn.

CHAS. A. WHEELER .... Jan. 8, 1901
Prof. of Mathematics, Conn. Agricultural College, Storrs, Conn.

FREDERICK I. WHEELER .... Aug. 27, 1901
U. S. Engineer's Office, New London, Conn.

ELI WHITNEY .... March 30, 1900
President New Haven Water Co., New Haven, Conn.

GEORGE E. WHITNEY .... March 30, 1900
Superintendent Stamford Water Co., Stamford, Conn.

ERNEST W. WIGGIN .... March 30, 1900
Second Assistant Bridge Engineer, N. Y., N. H., & H. R. R.,
New Haven, Conn.

RALPH M. WILCOX .... Jan. 8, 1901
City Engineer, Middletown, Conn.

J. K. WILKES .... April, 1884
City Engineer, New Rochelle, New York.

THEODORE WIRTH .... July 18, 1899
Superintendent Public Parks, Hartford, Conn.

HENRY A. WOLCOTT .... July 18, 1899
Mechanical and Civil Engineer, Hartford, Conn.

CHAS. N. WOOD .... Aug. 14, 1900
Civil Engineer, Norwalk, Conn.

CHARLES LEWIS YOUNG, JR. .... Jan. 9, 1900
City Engineer's Office, Hartford, Conn.

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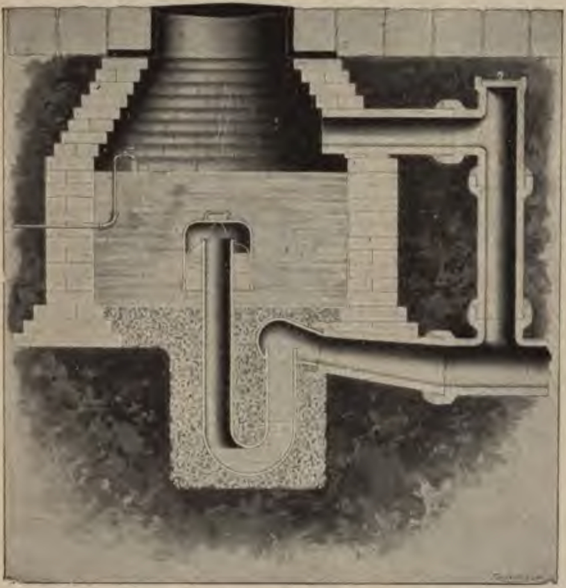

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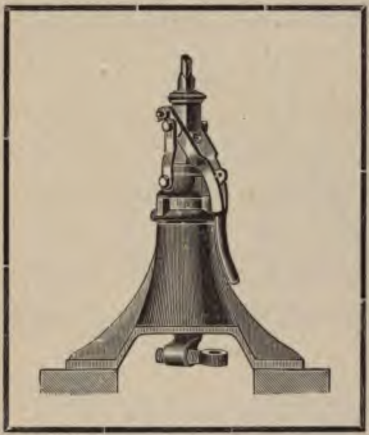

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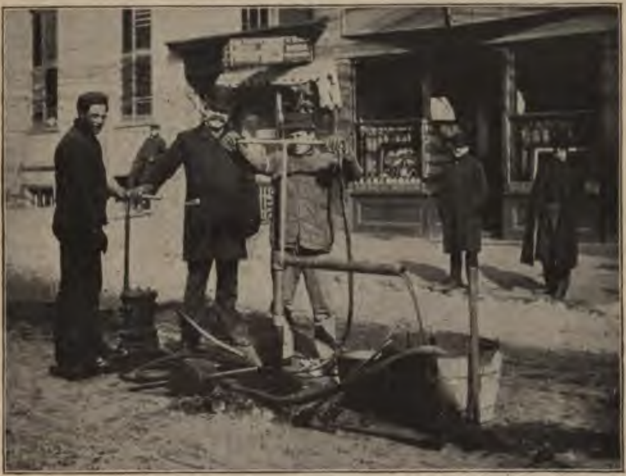

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Gentlemen: We have used one of your No. 1 Deck Pumps this winter in boring to locate rock along the line of proposed sewers and find it very satisfactory, having drilled with its assistance 72 holes, aggregating 661 vertical feet, through hardpan. The man in charge of the gang says it is quicker and better to use your pump than to couple onto the fire hydrants, as we have done heretofore. I enclose a photograph showing the outfit in operation.

Very truly yours,

(*Signed*) *FREDERICK L. FORD,*

City Engineer.

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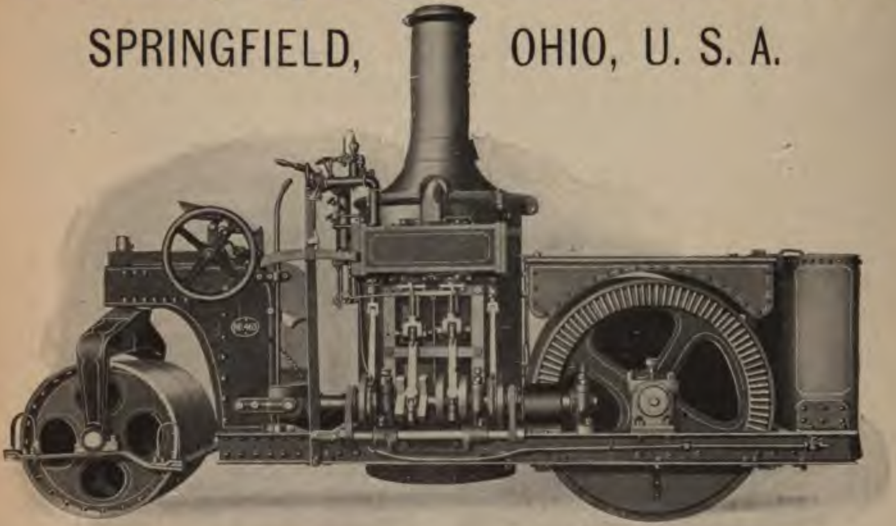

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In 1892.	**York St. (one side), bet. Chapel and Elm Sts.,**	**633.3**	**sq. yds.**	Sand Joints
In 1893.	**Ashmun St., bet. Henry and Gregory Sts.,**	**2,432.1**	" "	
In 1894.	**Chapel St., at and near State St.,**	**947.6**	" "	
In 1900.	**Grand Av., bet. the Mill and Quinnipiac Rivers,**	**22,697.2**	" "	
In 1900.	**Commerce St., bet. Cong. Av. and Whiting St.,**	**2,708.5**	" "	
In 1901.	**Chapel St., bet. York and State Sts.,**	**13,491.8**	" "	Grout Joints
In 1901.	**Congress Av., bet. George and Temple Sts.,**	**4,206.0**	" "	
In 1901.	**Crown St., bet. State and Temple Sts.,**	**3,567.8**	" "	
In 1901.	**Elm St., bet. State and York Sts.,**	**13,377.2**	" "	
In 1901.	**George St., between State and Temple Sts.,**	**5,661.2**	" "	
In 1901.	**Temple St., bet. Elm St. and Congress Av.,**	**7,480.0**	" "	
In 1902.	**Olive St., bet. State and Water Sts.,**	**10,341.0**	" "	
	Total - - - - - - - - -	**87,543.7**	" "	

In 1896-7 about seven miles of "Syracuse" brick gutters for macadam and asphalt pavements were laid. During the year 1902, 545,000 "Syracuse" brick were purchased by the city for repairing pavements not originally laid with "Syracuse" brick. None of the above-named localities has been repaired excepting where the pavement was torn up for a specific purpose. The above total area represents about four miles of streets.

Very truly yours,
HENRY J. KELLOGG,
Asst. City Engineer,
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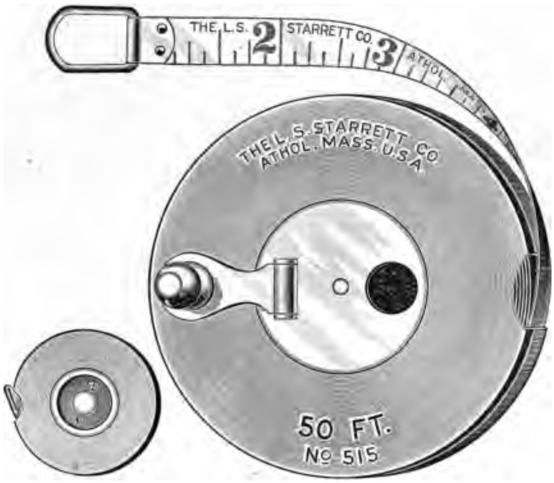
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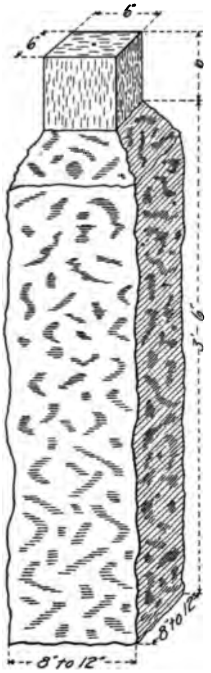

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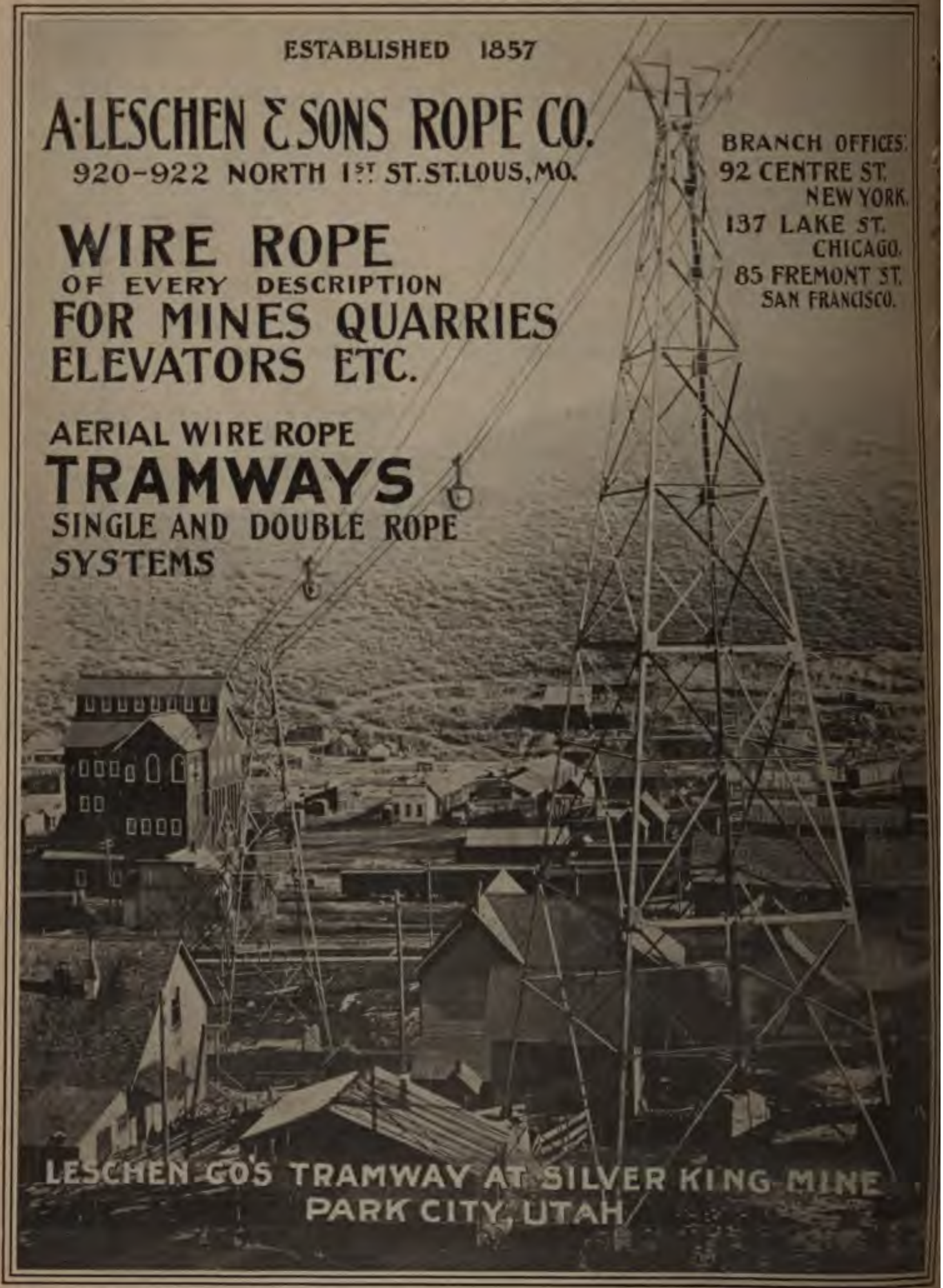

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